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ABSTRACT

This packet contains five units of informational materials and transparency masters with accompanying scripts, skill sheets, and safety tests for teacher and student use in an agricultural mechanics course in vocational agriculture. The first unit introduces the agricultural mechanics shop, covering the following topics: importance of agricultural mechanics, shop rules and regulations, and shop safety and clean-up. The second unit covers farm carpentry in 10 topic sections that deal with using hand tools, along with providing information on uses of various types of lumber. In the third unit, cold metal work is outlined, with eight topic sections covering identification of common kinds of metal, cutting cold metals, filing cold metals, bending and shaping metal, drilling holes, taping and threading, bolting and riveting, and removing broken bolts. The fourth unit covers selecting and applying paint, while the final unit discusses conditioning hand tools. Each topic section of the units contains information sheets, scripts for transparencies, references, and transparency masters. These materials are for teacher use. For the student, the packet contains 39 agricultural mechanics skill sheets, each sheet with an identified skill and a list of materials needed, procedures and illustrations, and additional suggested student activities. A battery of tests on safe uses of various tools completes the student materials. (KC)

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AGRICULTURAL MECHANICS

V-A-1 to V-E-1

BASIC V.A. I

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AGRICULTURAL MECHANICS

Unit A: Shop Orientation

Topic 1: Importance of Agricultural Mechanics

Suggested Procedure and Activities: A class tour to acquaint the student with the shop working areas and equipment will be helpful.

1. The Meaning of the Term Agricultural Mechanics

a. Agricultural mechanics may be incorrectly referred to as "farm mechanics", "agriculture shop", "farm shop", and "shop", to different individuals. The more commonly used term to identify this particular phase of the vocational agricultural program is agricultural mechanics.

b. The Vocational Agriculture Program

The instructional program in vocational agriculture consists of:

- Agricultural mechanics
- Animal science
- Soil science
- Plant science
- Agricultural management
- Supervised experience programs
- Leadership

The total time devoted to agricultural mechanics exceeds the time devoted to any other subject area. Also, the number of periods used for it in each of the four years is equal to or more than the allotted time for other subjects except in two areas, Animal Science in V. A. II, and Farm Management in V. A. III.

c. The Major Areas Included in Agricultural Mechanics

Shop Rules and Regulations

Shop Safety and Clean-Up

Farm Carpentry
Identification, use, and conditioning of:
- Nail hammers and wrecking bars
- Hand planes

  - Hand saws
  - Wood chisels
  - Braces and bits
  - Screwdrivers
- Identification and use of:
  - Screws, nails, bolts, staplers, and other fasteners
  - Mechanical drawing equipment
  - Measuring and marking devices
- Construction of a wood project

Cold Metal Work

- Identifying common kinds of metals
- Cutting cold metal
- Filing cold metal
- Bending and shaping cold metal
- Drilling holes in metal
- Tapping and threading
- Bolting and riveting metal
- Removing bolts from metal

Conditioning Hand Tools

Use of Power Tools

- Operating the bench or circular saw
- Operating the radial arm saw
- Operating the band saw
- Operating the scroll saw
- Operating the jointer
- Operating the planer
- Operating the drill press
- Operating the grinder
- Operating portable hand saws
- Operating the hacksaw
- Operating other power hand tools

Hot Metal Work

- Arc welding
- Oxy-acetylene cutting and welding

Concrete

- The many uses of concrete
- Estimating amounts to use
- Construction of forms
- Placing and finishing concrete

Selecting and Applying Paint

- Brush painting
- Spray gun painting

Farm Electricity
Safety, electrical terms, wiring layouts and wiring
Electric motors

Agricultural Power - Small Gas Engines
Basic principles of four-cycle and two-cycle internal combustion engines
Disassembly and reassembly of small air-cooled engines

Tractor Maintenance
Proper operation of a tractor
Maintaining a battery
Changing the oil and replacing the oil filter
Servicing the transmission and differential
Maintaining the cooling system and servicing the water pump
Replacing the front wheel bearings
Adjusting the clutch, brakes, steering system, and alignment of the wheels
Maintaining the ignition and fuel systems

Farm Building Construction
Make complete plans before constructing or repairing a building
Select proper building materials

Use of the Farm Level

Planning and Constructing Farm Fences

2. Why It Is Important to Study Agricultural Mechanics

a. It is an accepted reality that the world is dependent upon mechanization or machine power to supply modern man with security, whether it be food, clothing, or shelter. The agriculturalist who does not know how to repair and maintain home conveniences, adjust farm machinery, remodel a building, repair a fence, use a farm level, and maintain electrical equipment may be recognized as an individual who needs more mechanical knowledge and skill to be a better farmer.

b. Mechanical knowledge and skills are very important for the following reasons:

Save the labor cost (50 percent of the cost of the article) on a needed project or repair job.

Make project or construction plans and figure materials needed.

Learn a skill by doing, and be better prepared to use the proper tools and equipment for the job.

Save time on a job that requires immediate attention.

Build projects needed for the supervised experience program.

Make dependable judgments regarding machinery adjustments and needed repairs.

Recognize quality work on any type of agricultural mechanics project and take pride in good workmanship.

Make estimates as to the cost of construction and repair jobs.

Help other students and friends on mechanical problems. Be able to demonstrate shop skills.

Adjust to mechanical problems that arise after graduation.

Develop a home shop for the purpose of constructing needed projects and making repairs locally.

Form habits of neatness, industry, accuracy, and carefulness -- an asset to the trade and individual.

Serve as a good unspecialized mechanic, not as a specialist or expert. Commercial shops are equipped to perform specialized jobs, such as a complete tractor overhaul.

3. The Use of Agricultural Mechanics in Agriculture Experience Programs

a. It is a known fact that knowledge and skill developed in the agricultural mechanical program is very important in an on-the-job training program (cooperative part-time training). Listed below are occupations and a knowledge of the skills that may be required of the trainee.

Ranch Employee
Concrete construction
Feed equipment
Fencing
Carpentry
Welding
Use of hand power tools

Horticulture Employee
Greenhouse humidifiers
Tree injectors
Tractor and equipment skills
Turf pluggers and sweepers
Use of hand power tools

Swine Employee
Feed equipment
Concrete construction
Carpentry
Use of hand power tools

Fertilizer Employee
Operating and maintaining tractor and fertilizer machinery for handling, mixing, and distribution

Agricultural Machinery Mechanics Helper and Repairman
Farm power, tractor, and equipment maintenance and repair

b. A mechanical knowledge and some skill in the use of equipment is helpful in each of the following trainee occupations:

Horse Farm Employee
Poultry Farm Worker
Dairy Farm Worker
Poultry Processing Plant Employee
Forestry Employee
Wildlife Conservation Employee
Wool and Mohair Warehouse Employee
Meat Processing Plant Employee
Milk Processing Plant Employee
Irrigation Equipment Sales and Serviceman
Agricultural Chemical Sales and Serviceman
Feed Sales and Serviceman
Feedlot Employee
Cotton Ginning Employee
Crop Farm Employee

c. Agricultural mechanics has been associated with production agriculture since its early beginning under the Smith-Hughes Act. Due to a continuous increase in farm mechanization and technical improvements in agriculture, agricultural mechanics has become a part of the vocational agricultural curriculum.

A beef cattle project with an improved pasture requires the "know how" to operate, adjust, maintain, and repair the tractor; plows; fertilizer spreader; mower; hay baler; seeder; and hauling machinery. Also, it requires skill in carpentry, plumbing, concrete work, and electricity in order to repair and construct equipment and facilities for the cow herd and pasture.

Regardless of the size of a production project, agricultural mechanical skills may be needed in the project program. As an example, if broilers are the supervised farming program, a brooder, feeders, and pens will be needed, all of which may be constructed in the vocational agriculture shop.

Shop projects may be centered around the production project program, but much of the improvement project program involves agricultural mechanics, especially the efficiency operations with crop and livestock and improving the family's home conveniences.

Supplementary farm practices may involve considerable agricultural mechanical skills. The construction of feeders, tool cabinets, breeding crates, feed carts, and workbenches are just a few of the practices that develop agricultural mechanical abilities.

4. An Opportunity to Select Shop Projects

a. Before a shop project is selected, there are certain factors that should be considered.

The project should improve knowledge and skill in the use of certain tools and equipment and train for more efficient workmanship.

The shop project should have practical value in the agricultural experience program, at home, or on the farm.

The shop project should be one that can be accomplished. The student should make the plans, secure the materials, and perform an accreditable job.

Determint whether or not the shop project is too costly to be practical.

Decide if the shop project requires too much time.

Consult parents about the needs and value of the project to be constructed or repaired. The attitude of the parents should be favorable toward the proposed project.

Determine if the shop project will give a feeling of pride due to "a job well done".

b. It should be recognized that a shop project, whether it be overhauling a piece of machinery or building a step ladder, is not just a job (busy work) or a chore to be done in the shop, but it involves theory and practice for developing skills that become habits of the individual in agricultural mechanics.

References:

1. Durbahn, Walter E., Fundamentals of Carpentry Tools, Materials, and Practices, Volume I, American Technical Society, Chicago, IL, 1971.

2. Phipps, Floyd J., Mechanics in Agriculture, The Interstate Printers and Publishers, Inc., Danville, IL, 1967.

3. Phipps, Floyd J., Handbook on Agricultural Education in Public Schools, The Interstate Printers and Publishers, Inc., Danville, IL, 1965.

AGRICULTURAL MECHANICS

Unit A: Shop Orientation

Topic 2: Shop Rules and Regulations

Suggested Procedure and Activities: The shop rules and regulations may be listed on the board, or a printed list may be presented to the student during the discussion. The student may record them in his notebook.

1. Why Rules and Regulations are Important

a. Agricultural mechanics is a very important phase of the vocational agriculture program. Everyone enrolled in vocational agriculture has an opportunity to participate in the agriculture shop training program, and those enrolled in the shop program should demonstrate mechanical growth by improving their proficiency in shop skills. If the objective - to improve the mechanical ability in shop skills - is to be realized, then it is necessary that standards be developed to support a good agricultural mechanics program

b. Good agricultural programs are based upon standards which are partially supported by rules and regulations; agricultural mechanics is no exception. There must be rules in a shop program. Good habits are developed by conforming to good rules. The purposes of shop rules are:

To protect the learner while a skill is being learned.

To protect expensive equipment and hand tools.

To keep tools and equipment available and in condition for teaching skills.

To develop skills by using the tools and equipment properly.

To learn to respect properly conditioned tools and equipment and good workmanship.

To develop skills by drawing shop plans, figuring bills of materials, budgeting time, buying building materials, and constructing projects.

To develop a shop type behavior.

To learn to appreciate the value of good housekeeping practices.

To prepare and keep a good notebook and records.

To have a thorough understanding of the purpose of the agricultural mechanics program.

2. The Most Common Rules Observed in Agricultural Mechanics

a. Shop Safety - Safety rules are intended mainly to protect the shopworker, but they also protect the tools, equipment, and building. For example, if the worker fails to use the blacksmith's hammer on a cold chisel, and instead uses a claw hammer and pieces of the face break off, injuring the worker's face and shattering a window, shop safety has not been observed. Shop safety will be discussed in the next lesson.

b. Use of Shop Tools, Equipment, and Building - The purpose of the shop is to train the individual in shop skills; therefore, tools and equipment should be used properly at all times so that they will be available for use when needed. Proper use of the shop facility will lead to the following results:

The shop will be used only under proper supervision.
Shop tools, equipment, and supplies will remain in their proper place.
Tools and equipment will remain in a condition for training purposes.

c. Shop Behavior - Scuffling or horseplay endangers not only those involved in the act, but everyone in the shop. Loud conversation is distracting in the shop or the classroom. Walking instead of running is considered a must in shop rules. Talking to a classmate who is working with tools or equipment may create an accident or injury due to the individual being distracted from the work. Only tools that are approved by the teacher or instructor should be used.

d. Building a Shop Project - If the project is large it may require the drawing of a project plan, listing needed materials, and securing approval of the teacher and parents before beginning the actual work. It is considered a good practice to learn certain shop skills by first building the required shop project before constructing a personal project. All projects must show quality of workmanship.

e. Shop Program Schedule - Generally speaking, most of man's daily activities are based upon a time schedule. There must be a shop schedule if desired skills are to be learned while completing shop projects.

Time is an important factor, and it must be used wisely if progress is to be made in the shop schedule. Time must be considered in the shop activities listed below.

Any shop assignment, including lessons, should be completed as soon as possible, but quality should not be forfeited entirely for the sake of time.

There is a limit on the amount of time it takes to complete a shop project. Time is given to complete a drawing, figure a bill of materials, purchase the materials, and build the project. Remember, working with speed and accuracy is also an important skill to develop in the shop.

Some students require more time to learn a skill than others, but the time to practice a skill is limited by the shop schedule. For example, a student may be required to use a square, hand saw, hammer, screwdriver, and jack plane to build a small project. Even if the workmanship is of inferior quality, the student may be required to learn the use of other tools due to a time limit on the use of the saw, square, hammer, and plane.

The shop is open only a limited number of hours during the school day, so all work must be completed on schedule.

f. Neat Notebooks and Records - The theory usually precedes the laboratory work in the shop. The theory may include class discussions, classroom demonstrations, and tests, so it is necessary that shop information be recorded and filed in the student's notebook. Information from shop or project plans, bills of materials, and other general shop information is added to the notebook.

g. Use of Shop Supplies - There are rules governing the use of such items as nails, screws, bolts, welding rods, and other supplies that are managed by the shop program and made available for the students' use. For example, a student may underestimate the amount of nails needed to finish a project; therefore, he can buy them from the shop supply.

h. Use Good Housekeeping Practices - The shop must be kept clean, and the equipment and tools should be maintained in an orderly manner even when in use. Each student is required to participate in a good housekeeping program. A clean shop will have the following characteristics:

Clean floors
Tools in their proper places
Waste materials removed
Work benches clean of waste materials
Project materials in order
Shop supplies in order

i. Reporting System - Each student is responsible for reporting certain things dealing with the shop program. They are:

Tools and equipment that are damaged, broken, or not in condition to be used to produce good quality workmanship.

All fire hazards and other hazards endangering the student, such as oil on the floor, lack of ground wire on electric power equipment, and accidents and injuries occurring in the shop.

Defective or missing protective equipment and devices (goggles, shields, and guards) for use when using the grinder, welder, and other power-operated equipment.

Lack of enough work to stay busy during the shop period.

3. Shop Grading Systems

   a. Agricultural mechanics may be considered a subject in vocational agriculture that offers only practical work in the shop, but the theory must be learned before actually practicing the skill. Testing and grading for classroom work is considered very important in reporting a shop grade.

   b. The agricultural mechanics shop is considered a very important laboratory for learning mechanical skills. Each student is graded on how well he performs the assigned shop skills, the type of workmanship he exhibits on his shop projects, and how closely he adheres to the shop rules and regulations.

      The vocational agriculture grade is affected by the agriculture mechanics grade. The performance in the shop could help or hinder the individual student when grades are totaled.

References:

1. Phipps, Lloyd J., Mechanics in Agriculture, The Interstate Printers and Publishers, Inc., Danville, IL, 1967.

AGRICULTURAL MECHANICS

Unit A: Shop Orientation

Topic 3: Shop Safety and Clean-Up

Suggested Procedure and Activities: Safety devices may be brought into the classroom and used as teaching aids during the discussion. Safety transparencies may also be used as a teaching aid.

1. Importance of Safety Measures in Agricultural Mechanics

   a. In a recent year, the agriculture industry lead all other industries in the number of deaths and injuries caused by accidents. Agricultural machinery was the major source of the recorded accidents. There are about 2,000,000 disabling injuries each year in all the major industries, and about 290,000 of these are in the agriculture industry.

   b. Everyone hopes to live a life free of accidents and illness. Industry today wants safe and efficient employees. It wants employees who can advance in their work. If the employee receives a permanent injury, there may be a reduction in the earning power due to a skilled worker becoming an unskilled worker. The family standard of living may be lowered, and the injured employee may need to go through a retraining program. Many people endure this type of experience each year.

   c. When visiting a grain elevator, cotton gin, oil mill, fertilizer factory, oil refinery, textile mill, machinery repair shop, machine shop, paint factory, or feed mill, notice how signs and warning signals attract attention to danger areas. The signs may be in the form of color codes and the signals only a flashing light. Many of the danger zones have warnings for the benefit of the employee, because the employer realizes that accidents are a preventable waste.

2. Safety Goes Beyond the Use of Tools

   a. The student is usually not like the safe electrician who automatically keeps all tools in good condition, knows exactly how to install wires and fixtures without endangering himself and others, knows about the dangers of electricity, and has a complete knowledge of the field work. The electrician's entire education on the subject has caused him to develop a safe attitude. So, the electrician's education on the subject includes habits, skills, knowledge, and attitudes favorable to safe work.

b. The student must become safety conscious if he is to develop safety habits. If he knows that the way he is doing something is dangerous, he should stop and change to a safer way. An accident might be prevented.

c. If a student follows shop rules and regulations, there will be little or no danger of having a shop accident. One of the first requirements in an agricultural mechanics shop is to observe all shop safety rules. If the safety rules are not observed, accidents will happen. For example, a factory supervisor became lax and permitted his personnel to work without goggles; within one month eye injuries went up five percent. Rules are enforced to protect the student.

Transparency No. 1

3. Shop Safety Reminders

a. Good Housekeeping - A clean shop is usually a safe shop. Some examples of good housekeeping are:

Shop work benches are clean.

Shop floor is clean.

Fire hazard wastes (sawdust, old rags, and shavings) are removed from the shop.

Materials and supplies are restored to their proper place.

Tools are kept in their proper place.

Some examples of poor housekeeping include:

Dirty, wet, greasy floors

Tools lying around the shop

Materials protruding into open walkways

Nails projecting through boards

Loose objects and materials of various kinds on the floor

b. Use of Protective Devices - Eye protection is inexpensive, and good eyesight is priceless. Some injuries may be as slight as a scratch, but others may be permanent. Safety devices and their uses include:

Goggles - When welding, grinding, drilling, or chipping certain objects, when using the wire brush, and when handling certain chemicals, goggles should be worn.

Protective Clothing - Clothing should be free of flammable materials, pockets, and ragged ends when welding. Also, the sleeves and collar should be buttoned. High-topped shoes may eliminate burns from slag or sparks created by the welder. Loose clothing, shirt tails out of trousers, long sleeves, and ties are shop hazards when using power tools.

Gloves - Hand pads or gloves are necessary when handling sharp, heavy, hot, or rough materials around a shop. When welding, fire resistant gauntlet gloves must be used to protect the hands and wrists from burns.

Welding Helmet - A welding helmet is absolutely necessary for protecting the eyes and face from arc rays and splattering hot metal particles.

Respirator - Respirators are used to protect the student from inhaling paints and their ingredients when spray-painting.

Transparency No. 2

c. Behavior in the Shop - Shop workmanlike manners should be practiced at all times. Some bad behavior practices are:

- Scuffling
- Wrestling
- Giving the "hot foot"
- Being idle
- Running
- Talking to classmates
- Pushing
- Tripping
- Loud talking
- Hurrying on project
- Playing with tools
- Disobeying other shop rules

One reckless student can make the entire shop unsafe. The reckless shop student should be considered in the same light as a reckless driver; that is, he is failing to consider his safety and the safety of his fellow students. Good citizenship is regarded very highly in the shop.

d. Handling and Placing Materials Used in the Shop - There are several methods the student can use to properly handle and place materials in the shop.

Heavy objects in farm machinery work should be handled by blocks or block and tackle, suspended from an A-frame or other well-supported structure.

To lift a heavy object by hand, a student should use the following procedure:

Lift with the legs to avoid back and abdominal injuries.

The feet should be kept apart, knees bent, and the back straight as the load is lifted with the legs.

The load is lowered to the floor using the same method as when lifting except that the knees are bent downward.

While carrying a load, the hands and body should not be shifted to another position.

If the load is heavy, ask for help.

Rough materials and metal should be handled with gloves.

Materials should be stacked in a place that is a safe distance from aisles, working areas, and entrances. The materials should be stacked in such a way that they will not slip, crush, or fall. Materials should be handled in such a way that the pieces or parts will not strike anyone in the working area. More than 25 percent of all disabilities are caused by the improper handling of materials.

e. A ladder is a very important piece of shop equipment. Ladder safety depends upon how and where the ladder is used. A makeshift box or crate should not be used in place of a ladder to inspect machinery, replace ceiling light bulbs, paint walls, hang fixtures, or work on anything above one's reach. The following ladder safety measures should be observed:

Check the ladder for missing cleats.

Check the ladder rungs for cracks and weaknesses.

Check the ladder for broken spreaders.

The base of a straight ladder should be about one-fourth its length from the wall.

A folding step ladder should be opened and locked open.

Use both hands when climbing a ladder, and do not reach for an object too far away when on a ladder.

Transparency No. 3

f. Safety Colors - Many agricultural mechanics shops have adopted a safety color code as a safety practice. The shop becomes a safer place to work after the student learns the meaning of the colors. The color code is universal in that the same safety colors are used for all factories, shops, and agriculture. There are seven colors that are commonly used in the color dynamics program. They include:

Red - This color indicates the locations and the equipment to extinguish fires. The exits are also red.

Orange - Orange means danger. It refers to moving parts. Power tool guards, belt guards, cutting edges, and the inside doors of fuse and switch boxes are painted orange to designate the location of dangerous parts.

Yellow - The color yellow designates caution as applied to operating wheels, levers, and other controls. It is used to mark aisles, handrails, equipment location, and hazardous places that may cause falling.

Yellow and Black - These colors point out obstructions or parts of shop equipment that may endanger the individual if he falls against it.

Green - The color light green is found on the body and base of power tools such as table saws, grinders, drill presses, and work benches.

Ivory - This color is used for tops and edges of work benches, insides of cabinets, and non-movable edges of power equipment.

Green - Safety green is a color to mark first-aid equipment. It is used on first-aid cabinets in the shop.

Transparency No. 4

g. Fire Prevention and Fire Fighting - Most fires in the shop are the results of thoughtlessness of the individual. In reality, almost all accidents in the shop are caused by thoughtlessness. Fire prevention and control practices include:

Locate the fire extinguisher stations and identify the types to use on certain types of fires.

If a blanket is available, know how to use it to extinguish clothing fires.

Dispose of all flammable objects such as oily rags, scrap materials, and shavings.

Check the location of flammable materials (paints, varnish, lacquer, and paint thinners) before igniting acetylene torch or turning on welder. Gasoline should not be used in the shop.

Store paint, lacquer, paint thinner, and other flammables in a metal cabinet in the shop.

Flammable liquids should never be poured down drains. Such materials create dangers in sewer lines.

There are many solvents much safer than gasoline; therefore, they should be used for cleaning purposes in the place of gasoline.

Many serious accidents have been caused by welding on or cutting on containers which held flammable materials. Such containers should be filled with water, and the space above the water level should be vented. An empty gasoline barrel may be more dangerous than a full barrel. The gasoline vapor remains after the gasoline has been removed. Certain chemicals that are shipped in metal containers are also volatile.

4. Safety Practices in the Shop

a. Hand Tools - Over one-fourth of all shop injuries are caused by the use of hand tools. The injuries stem from three principal causes:

Improper use of the tool
Using the wrong tool for the job
Using defective tools

Transparencies Nos. 5 and 6

b. Precautions to Observe When Using Hand Tools - These precautions are:

A dull tool may slide or stick to the material causing an injury; therefore, cutting tools should be kept sharp.

Tools with mushroom heads (cold chisel with spreading head) are dangerous. A chip may break off and strike any part of the body. Splintered, broken, or loose tool handles can also cause flying objects.

A screwdriver is not to be used as a cold chisel, pry bar, paint paddle, putty knife, or punch. Each tool is made for a specific job or jobs, and if the job is to be done safely and quickly, the proper tool should be used. Use the proper sized tool for the job.

No tool should be allowed to lie around. Tools should remain in their proper places when not in use, and the sharp edges of cutting tools should be protected. Sharp edged tools are dangerous if placed in improper locations.

Tools are never to be carried in the pocket. Sharp or pointed tools are very dangerous in any pocket on the body. A tool box or tool kit and belt tool holders are safe carriers.

Badly worn tools are dangerous, especially pliers and wrenches with jaws. Using a hammer to strike a handle or extended handle to gain more pressure is not a safe practice. Improper sized wrenches may slip on bolt nuts and cause injury to the knuckles. Adjust the jaws of adjustable wrenches so they will not slip.

Greasy or dirty tools are difficult to handle properly. Clean tools make the work more efficient. Tools should be cleaned before they are put on the tool rack.

All work should be held steadily and the cuts made away from the body except when using a draw knife. If vises are used to hold the work stocks, they must be mounted securely.

Tools that have tang handles should be provided with a slip over the handle to protect the hand. For example, a file is dangerous if used without a handle to cover the tang.

Transparency No. 7

c. Precautions to observe when using portable electric power hand tools include:

Check the tool before using. The three-prong plug (one of the prongs is for grounding the tool) should be free of damage.

Keep the cord out of the aisles or other traveled areas and protect it from hot or rough surfaces, oils, and chemicals.

Electric hand tools should not be used around flammable vapors or gases; a spark can cause an explosion.

The hands should be dry when using a power tool. Dry hands may reduce the shock effect if there is an improper ground or short in the tool.

Always remove the cord and plug from the outlet by grasping the plug instead of grasping the cord.

The tool should remain on a shelf or rack when not in use. The cord should be rolled loosely when storing the tool.

NOTE: Hand power tools should be used by experienced students, those that have been instructed in safe methods of using them.

d. Precautions to observe while working with electricity or electrical equipment include:

Locate and check the use of the master and other switches in the shop.

All electrical tools should be checked for damaged parts, plugs, cords, and grounding prongs or wires before using on any job. Sparking or smoking of a motor is a signal to disconnect the equipment and report the condition.

Extension cords should be of adequate size to handle the electrical load. Exposed wires, faulty plugs, and worn insulation are danger signs on extension cords. They should not be placed in aisles or pulled over sharp edges. Cords should be protected from damage by the power tool. They should be disconnected by pulling the plug from the outlet.

Electric portable tools should not be used on damp floors or with wet hands. Rubber-soled shoes are the safest shoes to wear when handling electrical equipment.

When fuses blow, there is an indication of an overload or a short. A supply of proper sized fuses should be kept on hand.

When cleaning electrical tools, the proper solvent should be used. Gasoline is very flammable and should not be used.

NOTE: An electrician considers all wires as live wires until proven to be different. Bare fingers are not used to check whether a circuit is energized or not. The control switch is locked open if work is required on the circuit.

When working with electricity, the following steps should be observed:

Splices should be soldered and taped.

Screws should be tightened firmly, connecting the wire to the fixture.

Proper sized wire should be used. Follow the rules of the National Electrical Code to determine the wire size.

e. Precautions to observe concerning special shop hazards include:

Chemicals (acids and caustics) should be used under the direct supervision of someone who is acquainted with their proper use and dangers.

Compressed air is very dangerous, and it should be used with caution when painting and cleaning clothing and equipment. It should never be used under the following conditions:

Pointing nozzle at the body as a prank; it can damage the eyes and ears very easily.

Kinking the line to cut off the air or reduce the air flow through the hose.

Cleaning the equipment where metal waste is located, without protecting the eyes.

When the pressure is too high for the job being done.

To remove liquid from surfaces.

5. First Aid in Agricultural Mechanics

a. Minor injuries, such as cuts, bruises, scratches, burns, or punctures, should be treated immediately. The shop first-aid kit may be a handy device to treat minor injuries. In many cases, the school nurse is called to assist with injury treatments. The student should report minor injuries to the instructor.

b. Major injuries, such as severe shock, scalds, burns, cuts, and broken bones, should be handled immediately by qualified school personnel and a physician. First-aid is administered before the student is sent to the hospital only if advised by the instructor; otherwise, the placing of splints, applying of tourniquets, or administering artificial respiration should not be a general practice by the student.

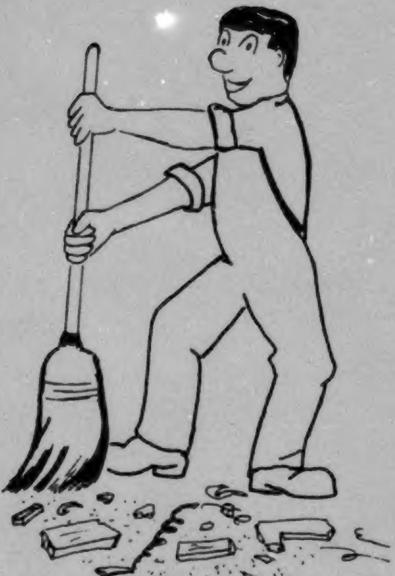
References:

1. Durbahn, Walter E., Fundamentals of Carpentry Tools, Materials, and Practices, Volume I, American Technical Society, Chicago, IL, 1971.

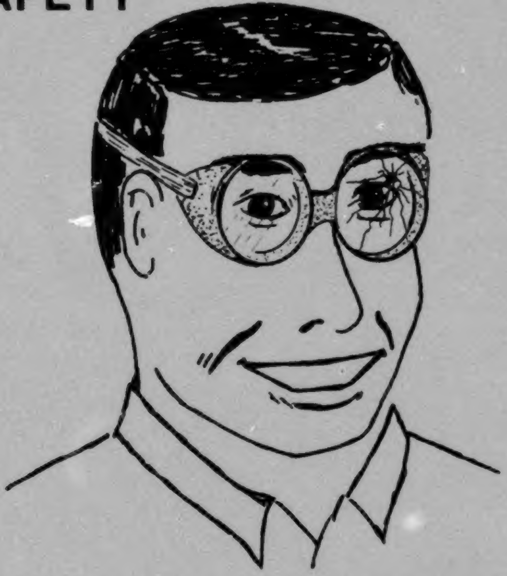
2. Phipps, Lloyd J., Mechanics in Agriculture, The Interstate Printers and Publishers, Danville, IL, 1967.

3. "Safety in the Agricultural Mechanics Shop," University of Illinois, Urbana, IL.

SHOP SAFETY

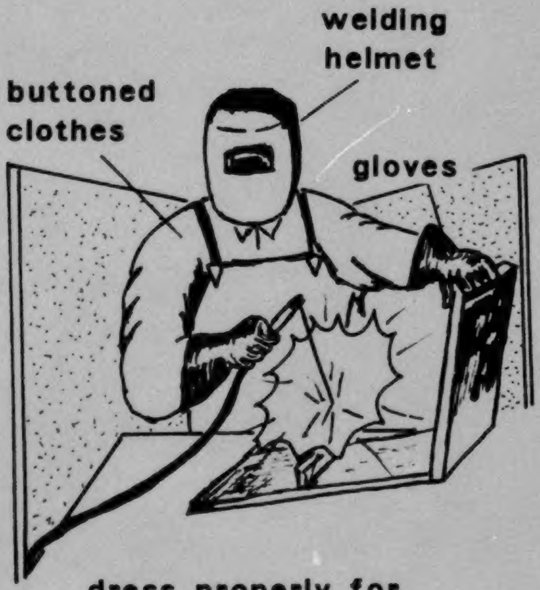


a clean shop is a safe shop

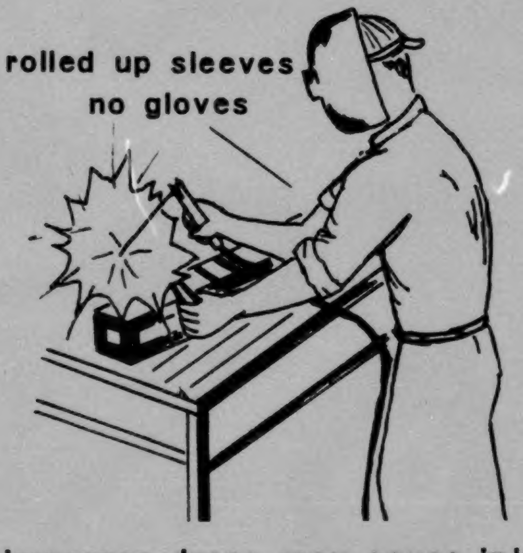


goggles protect the eyes

on some jobs

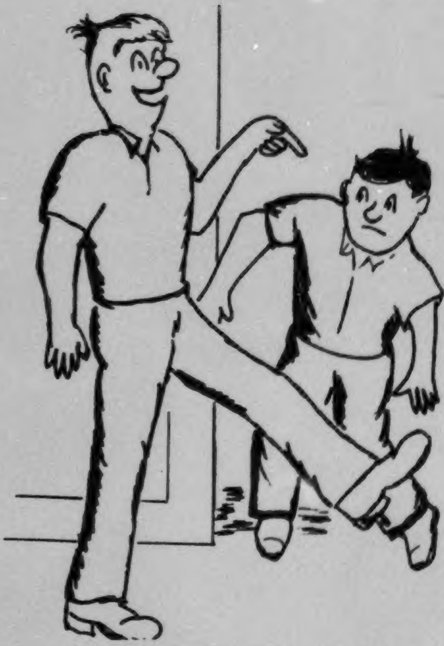

welding
helmet
buttoned
clothes
gloves

dress properly for
arc welding

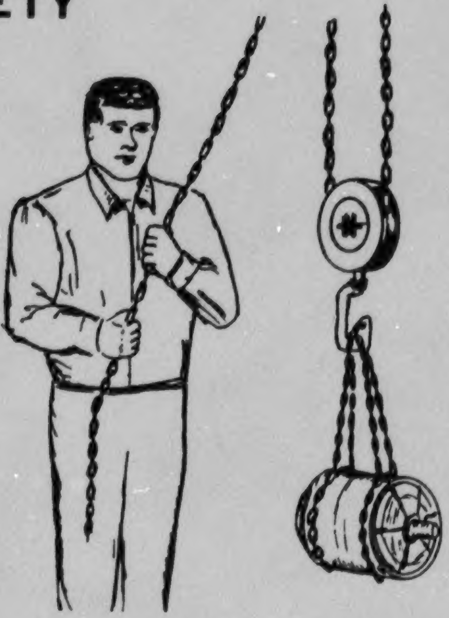

rolled up sleeves
no gloves

improper dress may cause injury

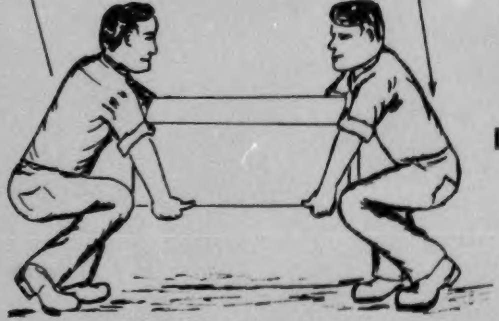
SHOP SAFETY



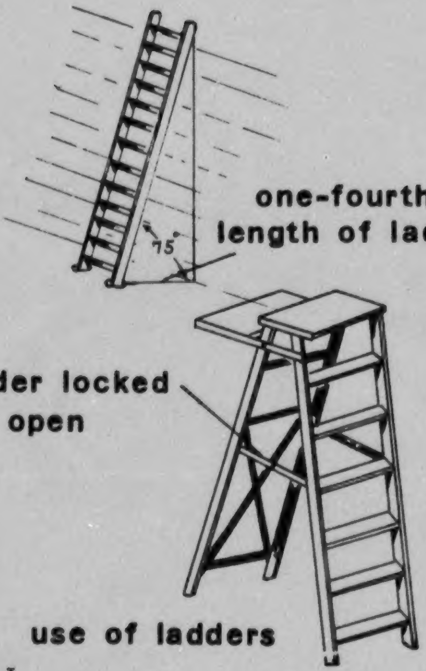
improper behavior is
dangerous



a safe method of
lifting heavy objects


straight back
lift or lower
with legs

use help to handle
heavy objects


75°
one-fourth
length of ladder
ladder locked
open

use of ladders

SHOP SAFETY COLORS

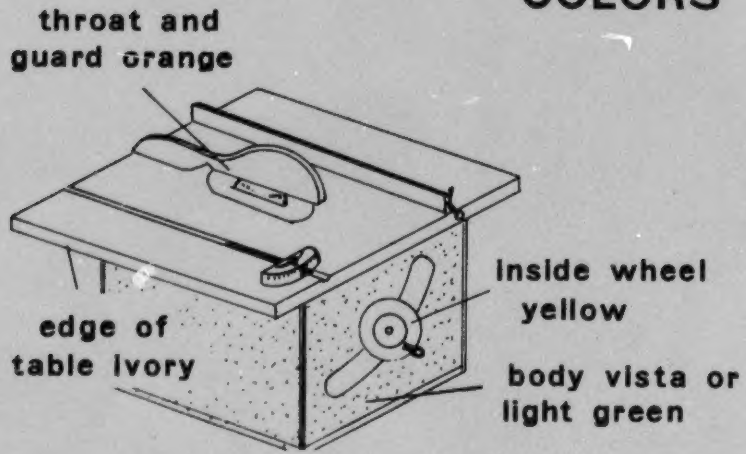
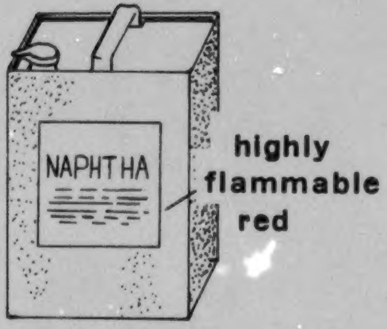
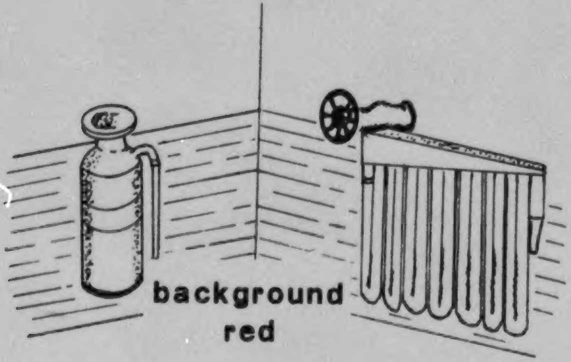

throat and guard orange
inside wheel yellow
edge of table ivory
body vista or light green

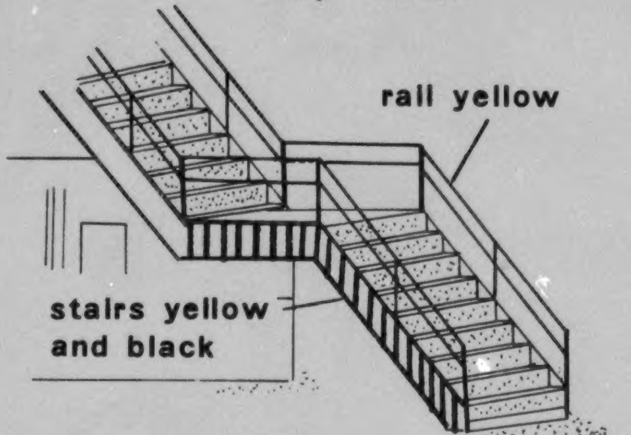
table saw


NAPHTHA
highly flammable red

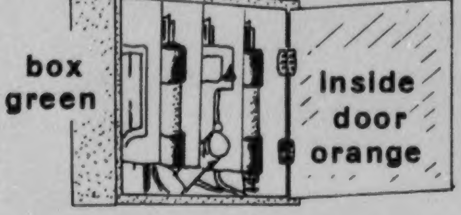
shop solvent


background red

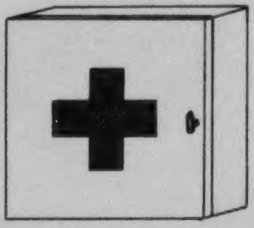
fire equipment


rail yellow
stairs yellow and black

stairs

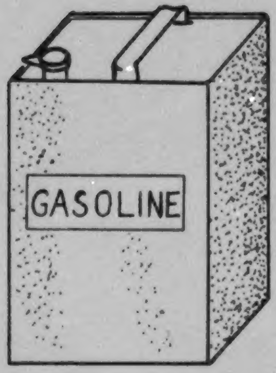

box green
inside door orange

fuse box

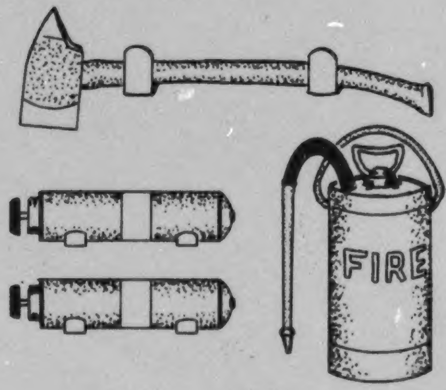


first aid safety green

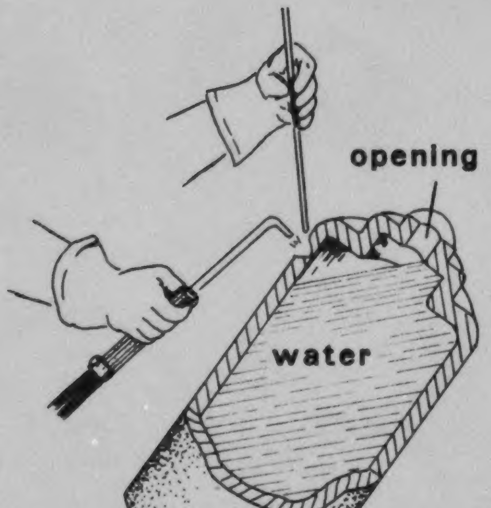
SHOP SAFETY
FIRE - EXPLOSIONS



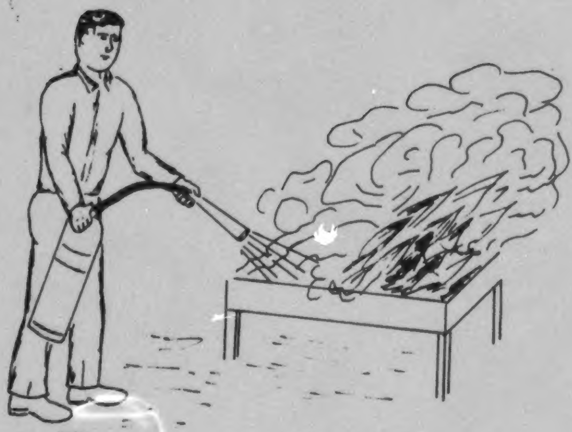
gasoline is not
a safe solvent



fire control equipment

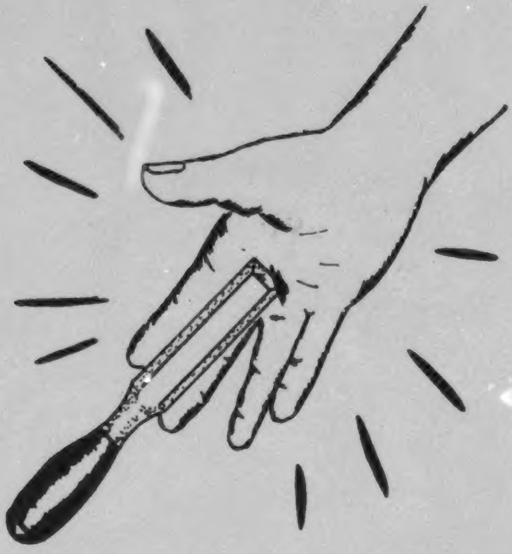

opening
water

proper safety practice
for welding and
cutting containers

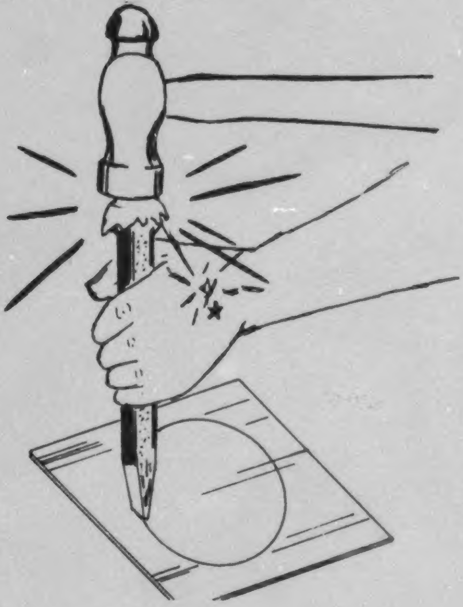


certain shop fires require
special fire chemicals

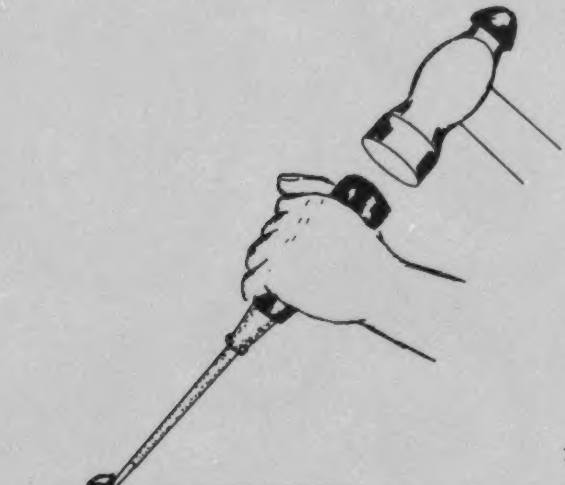
SHOP SAFETY HAND TOOLS



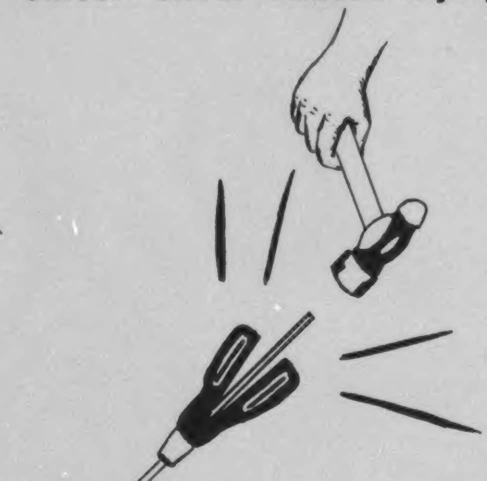
dull wood chisel slips causing injury



mushroom head cold chisel--silver causes injury

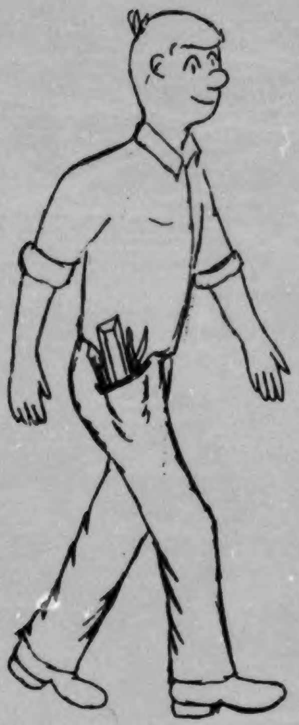


improper use of hand tool can cause injury

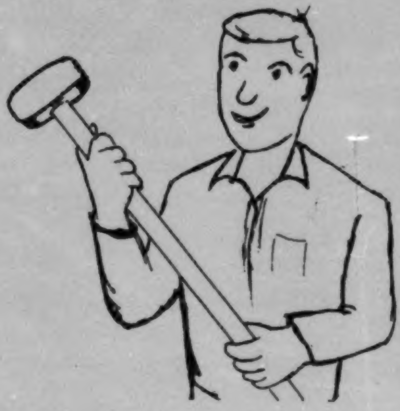


possible injury to body by improper tool use

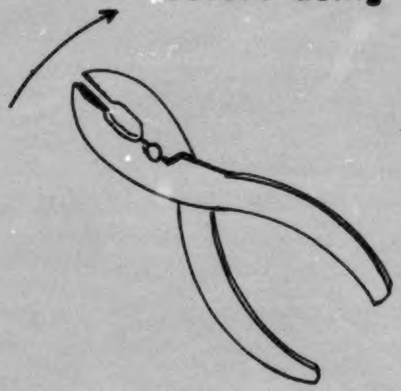
SHOP SAFETY HAND TOOLS



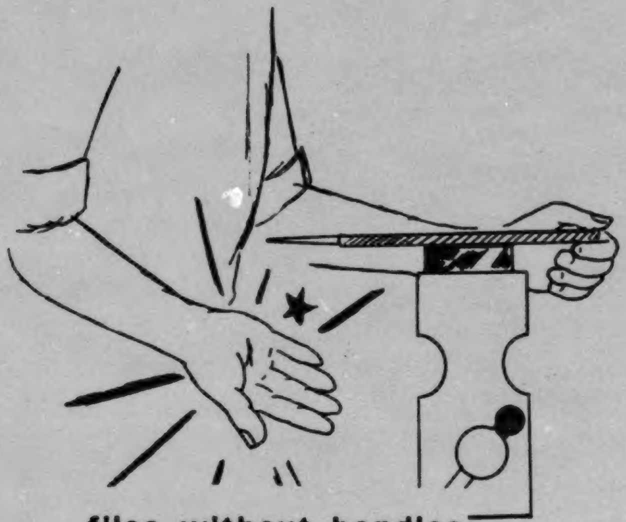
sharp edge tools carried in pockets are very dangerous



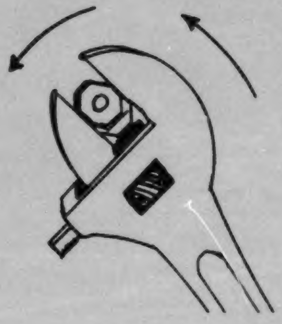
handles are checked before using tool



worn tools cause hand injuries

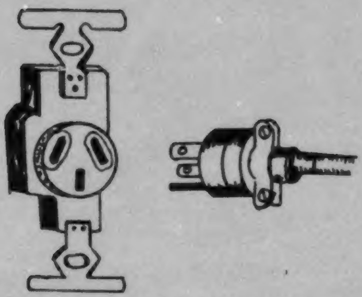


files without handles are dangerous shop tools

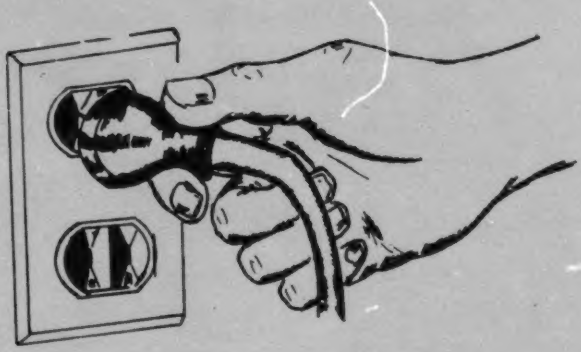


wrench used improperly may break causing injury

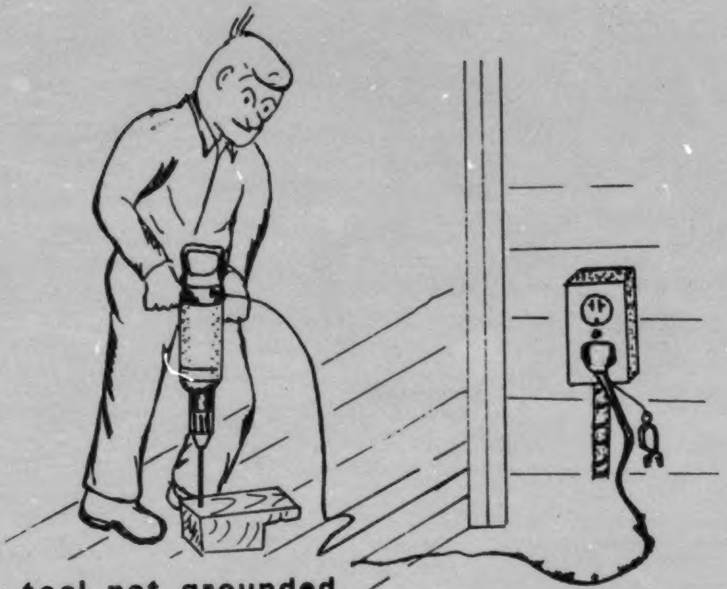
SHOP SAFETY



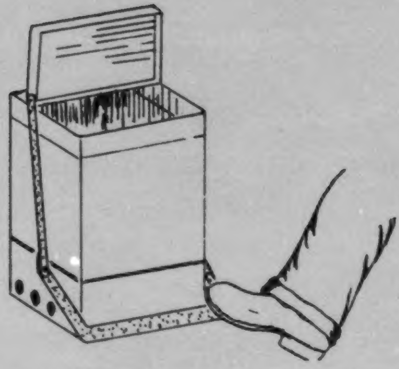
three-prong outlet
for grounding tool



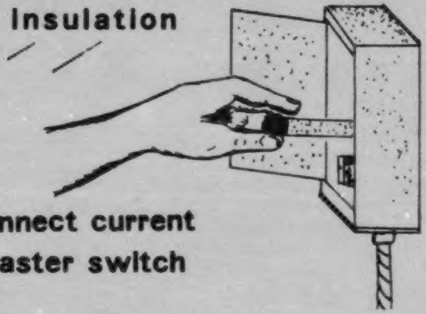
use plug to remove cord



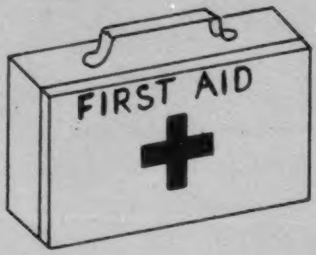
tool not grounded,
cord in aisle,
worn insulation



dispose of flammable
rags and waste



disconnect current
by master switch



a shop necessity

AGRICULTURAL MECHANICS

Unit B: Farm Carpentry

Topic 1: Nail Hammers and Wrecking Bars

Suggested Procedure and Activities: During the class discussion, a demonstration on the use of the hammer and wrecking bar may be presented with transparencies on the use of a hammer.

Transparency No. 1

1. Selecting Nail Hammers

a. The most common nail hammer used in the agricultural mechanics shop is the curved claw hammer. The second most common hammer is known as the rip hammer or the straight claw hammer.

b. The most common weights of nail hammers range from 13 to 20 ounces, although some hammers can be found as light as seven ounces. A 16-ounce hammer is the most popular, and it is known as the standard hammer size. The size of the nail will determine the weight of hammer to select for use.

c. The claw hammer is used for driving and pulling nails. It is better for pulling nails than the rip hammer. Rip hammers are used mainly to dismantle or tear down structures made of wood and to drive nails.

d. Hammers may be selected according to face. Bell-face hammers are used to drive the nail head flush with the surface of a board. The face is round or convex; therefore, hammer marks are not left on the board if the hammer is used properly. Plain-face hammers are easier to use than bell-face hammers, but hammer marks may show up on the board due to the flat face of the plain-face hammer.

e. Most nail hammers have wood handles. Wood helps to absorb the shock that enters the arm from the hammer blow. Shock causes the arm to tire quickly.

Transparency No. 1

2. Parts of Nail Hammers are Important

a. It is important to know the parts of nail hammers in order to make the proper selection for use.

b. The parts are:

Handle
Claw
Face
Neck
Adze eye
Check
Poll
Head

Transparency No. 2

3. Using Nail Hammers

a. Driving Nails - The following steps should be observed when driving nails:

The hammer handle should be grasped near the end. Check the face to see that it is clean, and check the handle for splinters and inset in the head.

Place the face of the hammer on the nail, then strike it with a light blow to start the nail. The nail should be held by the thumb and fingers near the nail head.

Deliver the remaining blows by putting the shoulder, elbow, and wrist into the action and striking the nail squarely on the head to prevent bending it and marring the wood.

The last blow or two should be lighter than the power blows in the center of the operation. This may prevent or eliminate hammer marks at the nail head.

b. Pulling Nails - The steps in pulling nails include:

Nails are pulled without damage to the hammer and the board by first slipping the claws under the nail head and raising the hammer handle until it is vertical.

Slip a block of wood under the head of the hammer while it is in the vertical position and continue pulling the nail unless there is too much strain on the handle.

It is better to pull a bent nail, caused by driving, and drive a new one in a new place.

If pulling the nail requires putting too much pressure on the hammer handle, a wrecking bar should be used instead.

c. Setting Nails - If casing, finish, or flooring nails are used it may be necessary to set the heads below the surface 1/16 of an inch by using a nail set. The set is braced by the lower fingers and tapped lightly with the hammer. Nail sets range in size from 1/32" to 4/32" at the tip or point.

4. Use of the Wrecking Bar

a. The most common ripping or wrecking bar is 24 inches in length. It has a gooseneck for pulling nails and a wedge-shaped, slightly bent end for prying loose boards. They can be found in sizes from one to three feet in length. Most wrecking bars are made of 3/4 inch octagon-shaped tempered steel.

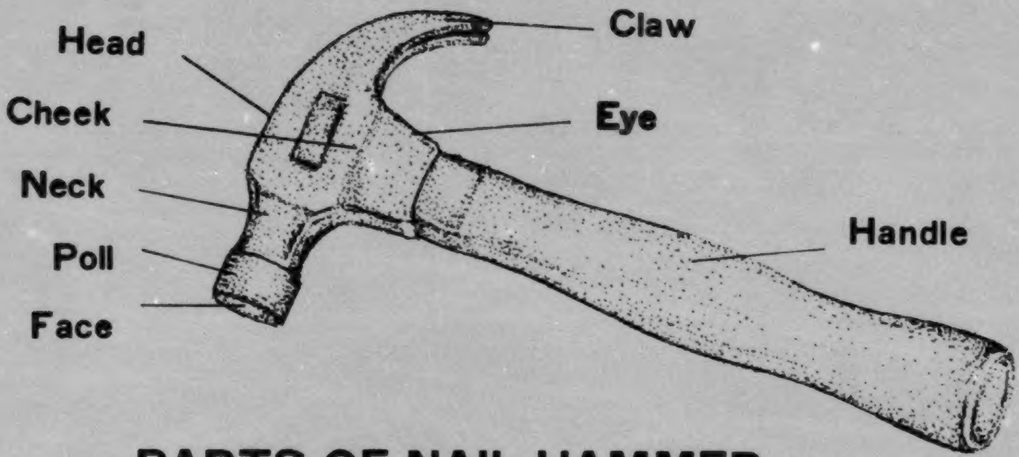
b. A wrecking bar is necessary for pulling large nails, wrecking buildings, opening wood crates, and dismantling many kinds of wood structures. A block of wood should be used under the gooseneck or the other end of the bar to protect the board from being marred. The wrecking bar is a protector of hammer handles, and it should be used if there is any doubt that too much strain is placed upon the handle. The wrecking bar is not a crow bar; therefore, it cannot be used to pry stones, timbers, or machinery.

References:

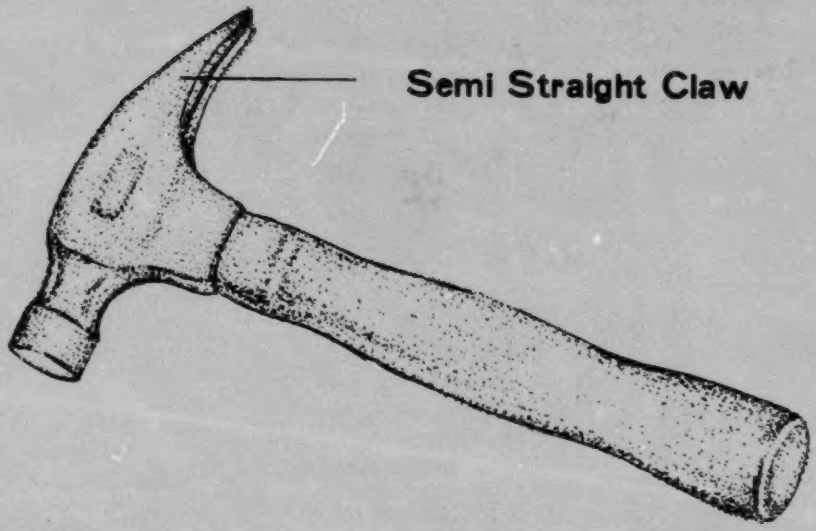
1. Durbahn, Walter E., Fundamentals of Carpentry Tools, Materials and Practices, Volume I, American Technical Society, Chicago, IL, 1971.

2. Wakeman, T. J. and Vernon, Lee McCoy, The Farm Shop, The Macmillan Company, NY, 1967.

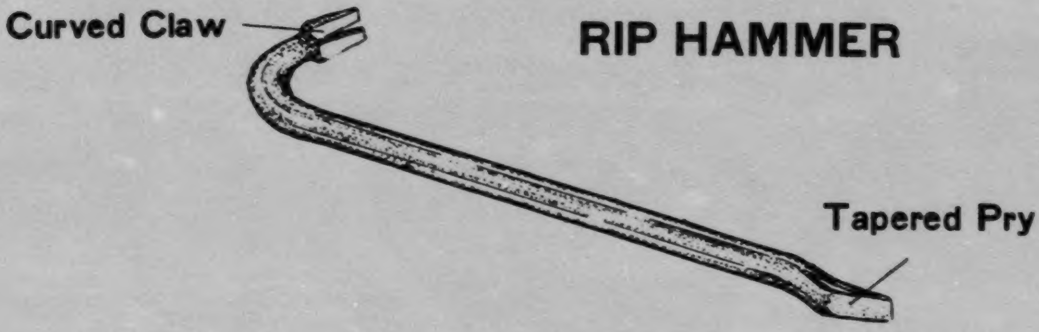
SELECTING NAIL HAMMERS


Head
Claw
Cheek
Eye
Neck
Handle
Poll
Face

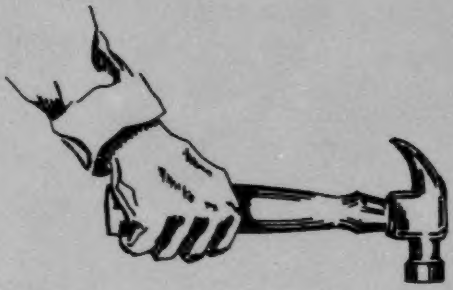
PARTS OF NAIL HAMMER

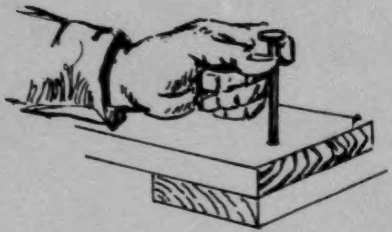

Semi Straight Claw

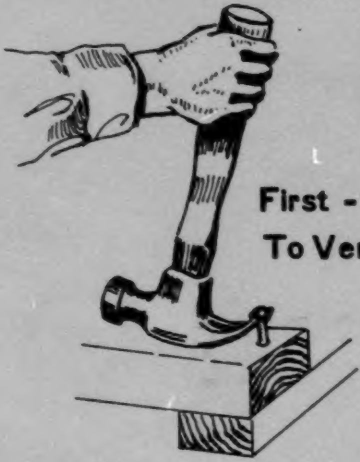
RIP HAMMER

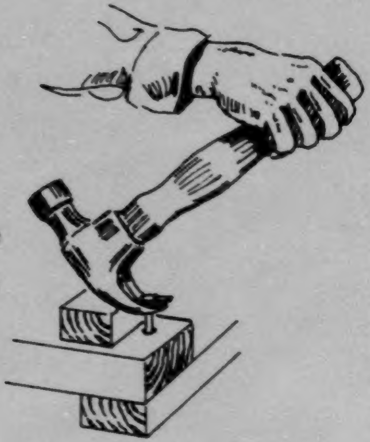

Curved Claw
Tapered Pry

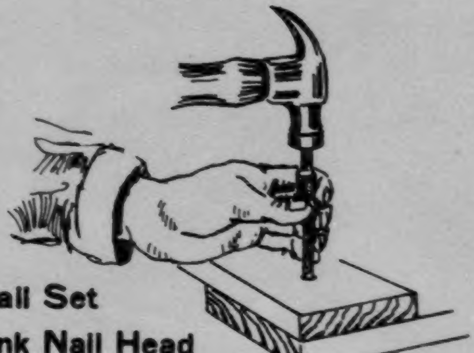
USING NAIL HAMMERS

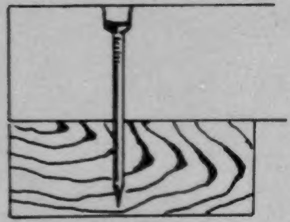

Grasp Handle Near End


Use Finger And Thumb To Hold Nail


First - Raise Handle To Vertical Position


Finish Pulling Nail With Block


Use Nail Set To Sink Nail Head


Nail Head Set 1/16 In. Below Surface

AGRICULTURAL MECHANICS

Unit B: Farm Carpentry

Topic 2: Hand Planes

Suggested Procedure and Activities: The use of the hand plane as a teaching aid may supplement the use of transparencies.

1. The Importance of a Hand Plane

a. The hand plane is considered useful as a paring or shaving tool for the following purposes:

Planing of small and large pieces of boards to smooth the surface, either on the face, end, or edge.

Planing to straighten and smooth surfaces for joining boards by gluing.

Planing to correct the size or dimension of an object or piece of material. For example: doors can be fitted to the door frame by planing.

Planing to eliminate twists or crowns (high parts in the face of a board).

b. Hand planes are also used where jointers and planers are not available to smooth, cut a board to a certain size, or correct board defects. Some of the first hand planes were made almost entirely of wood except for the cutting assembly. Wood hand planes are used for the same purpose as the modern planes are used today.

2. Selecting the Plane According to the Types of Job to Perform

Transparency No. 1

a. Jack Plane - This plane is the most commonly used for the many types of hand planes. It is from 11-1/2 to 15 inches long and is used mainly to smooth the surface by cutting with the grain. It can be used for chamfering (cutting board corners to form a bevel), smoothing large surfaces, and straightening board edges. The most commonly used jack plane is 14 inches long with a 2 inch wide cutter of blade.

b. Smoothing Plane - A smoothing plane is from 5-1/2 to 10 inches in length. It is used mainly for smoothing, surfacing, and finishing work. It can also be used to work end grain on boards. A plane with a 1-3/4 inch wide blade, 8 inches long is considered standard.

c. Block Plane - This plane is used for cutting end grain or working small pieces of materials. The average length of this plane is about 6 inches.

d. The Fore and Jointer Planes - These planes are used for straightening the edges of long pieces of material or wood objects. The fore plane is 18 inches long, and the jointer plane is 22 to 24 inches long. Both the fore and jointer planes are also used for smoothing edges.

e. Special Planes - The rabbet (for rabbeting edges), combination (for dadoing and grooving), and the circular plane (for planing concave or irregular surfaces) are of less importance to farm carpentry than the jack, smoothing, and block planes. Generally, special planes are used only for finishing type work. The duplex or full nose rabbet planes can be used to plane into corners. The most commonly used rabbet plane is 8 inches long with a 1/2 inch blade.

Transparency No. 2

3. Assembling and Adjusting the Plane Before Using

a. Assembling the Jack, Smoothing, Fore, and Jointer Planes

The plane iron bevel (cutting edge) must be opposite the plane iron cap when the two are put together. It is placed on the cap so that the curved part of the cap will not be dragged over the plane iron edge.

The plane iron cutting edge should protrude from 1/32 to 1/16 inch beyond the plane iron cap, or about one-half the thickness of the plane iron.

The plane iron assembly should be placed on the plane frog so that the plane iron lies on the frog and the lateral adjusting lever.

The lever cap is placed against the plane iron cap, the lever cap screw is fitted in the narrow part of the screw slot, and the cam is pushed down against the plane iron cap.

Transparency No. 3

b. Adjusting the Plane

The plane is held upside down, and the protruding cutting edge (1/64 inch or a sheet of paper thickness) is adjusted evenly across the plane bottom. The entire blade should cut evenly.

The depth of cut should be made by turning the adjusting nut that is found in front of the handle. Plane iron setting (angle and depth) may also be made by placing two fingers on each side of the iron or protruding cutting edge.

c. The block plane is assembled and adjusted in a similar manner as the jack plane except there is no plane iron cap attachment.

Transparencies Nos. 4 and 5

4. Proper Use of the Hand Plane

a. Holding the Board or Stock

The board may be placed in a bench vise for edge planing, or a V-shaped block may be used to hold it securely.

A board may be held for face planing by nailing a stop block to the table or by clamping a stop block firmly to a work table.

The board should be held so that face and edge planing is accomplished by pushing the plane with the grain of the wood.

b. Making the Plane Stroke

One hand is placed on the handle and the other on the knob, and the plane is placed on the board at the back of the area to be cut before any pressure is applied in making the stroke.

At the beginning of the stroke, pressure is applied on the knob; near the middle of the stroke the pressure should be the same on both front and back of the plane; and at the end of the stroke the pressure should be on the handle of the plane.

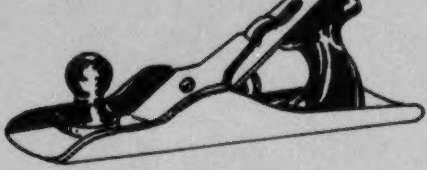
The plane can be lifted slightly, the heel lifted slightly, or the plane tilted to prevent dragging the blade over the surface on the return stroke. When not in use, the plane should be laid on its side.

Strokes made by a block plane are short. It is used in one hand with the forefinger placed on the finger rest.

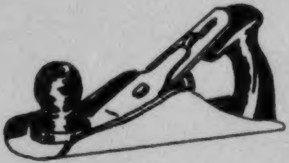
General practices in making the plane strokes include:

End grain should be planed half way from each side unless the corners at the ends and edges are beveled.

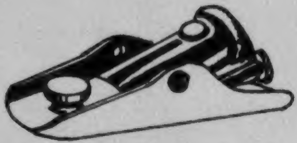
TYPES OF HAND PLANES



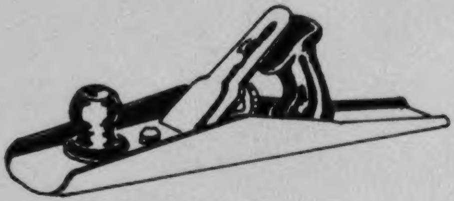
JACK



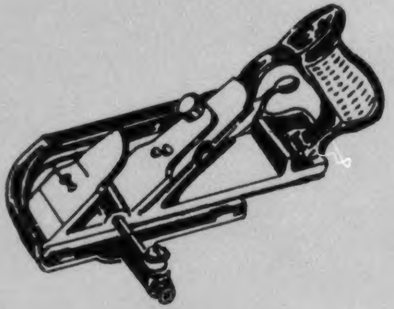
SMOOTH



JOINTER

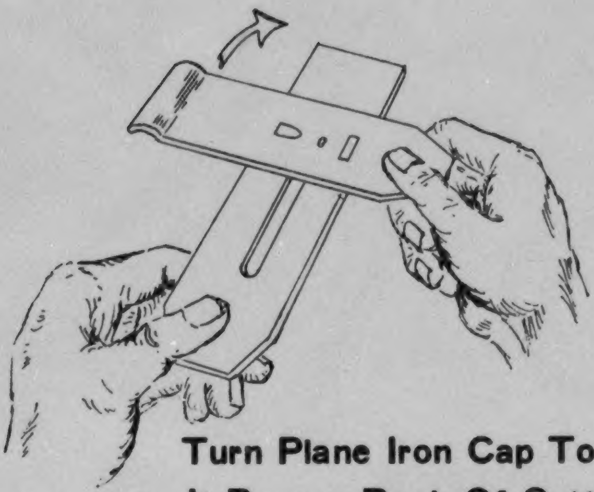


BLOCK

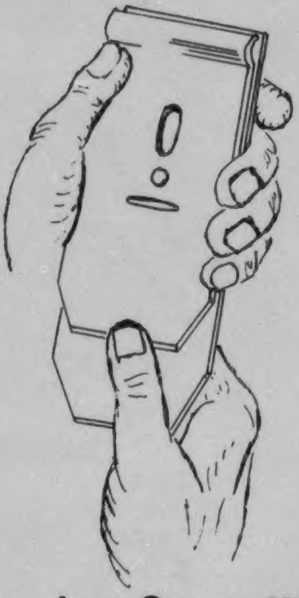


RABBET

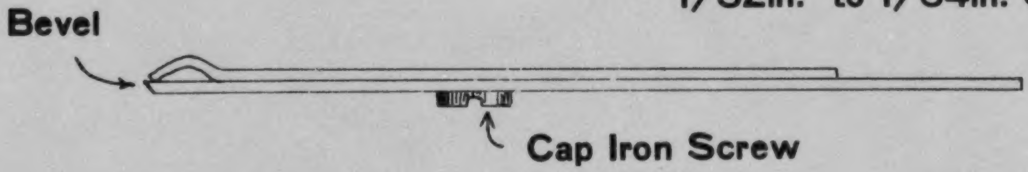
ADJUSTING IRON AND PARTS OF PLANE

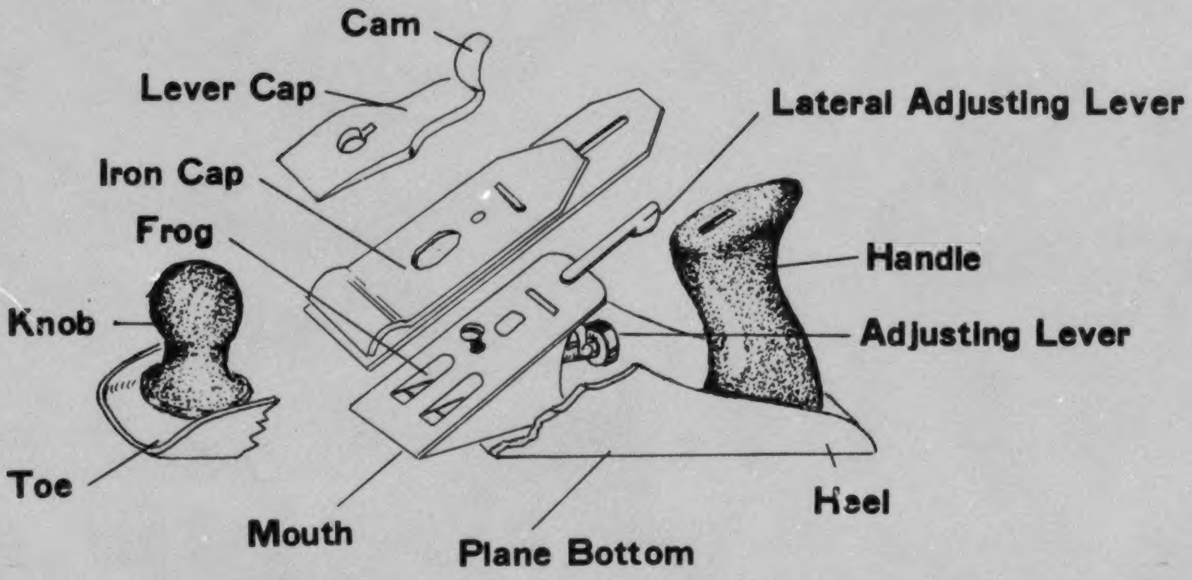


Turn Plane Iron Cap To The Right.
It Passes Back Of Cutting Edge

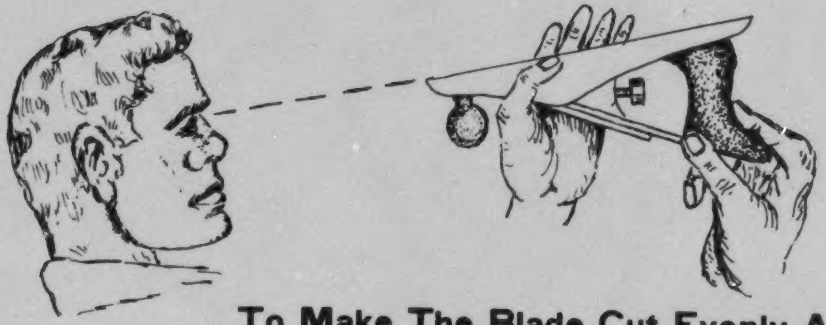


Slide Plane Iron Cap to Within
1/32in. to 1/64in. Of Blade Edge

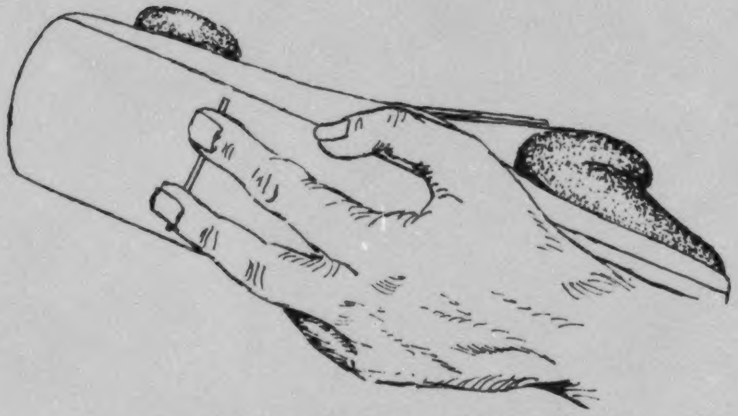

Bevel
Cap Iron Screw


Cam
Lever Cap
Lateral Adjusting Lever
Iron Cap
Frog
Handle
Knob
Adjusting Lever
Toe
Heel
Mouth
Plane Bottom

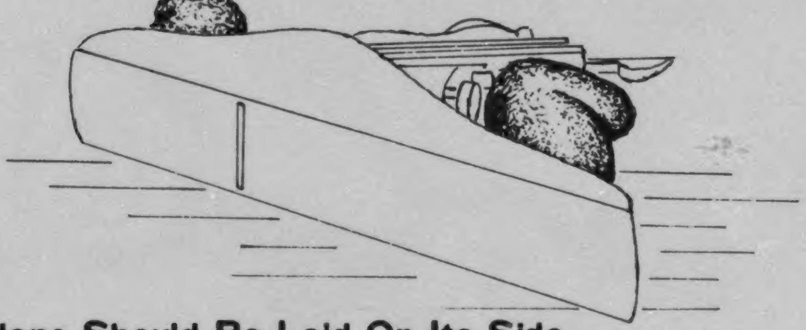
PLANE ADJUSTMENT AND CARE



To Make The Blade Cut Evenly Adjustment May Be Made By Sighting Across It

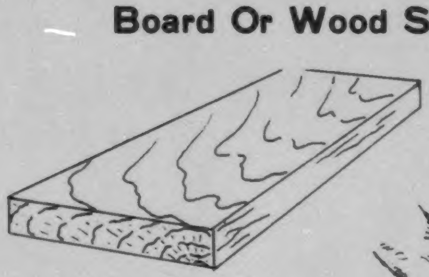


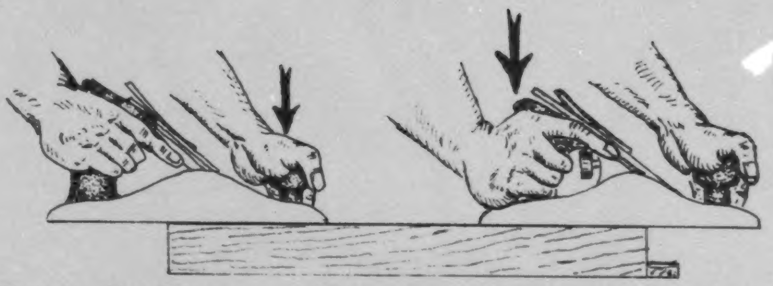
Blade Setting May Be Checked By The Feel Of Two Fingers.



Plane Should Be Laid On Its Side To Protect The Cutting Edge.

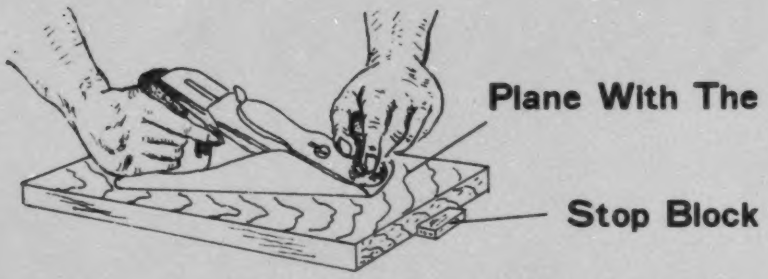
USE OF THE HAND PLANE


Board Or Wood Stock

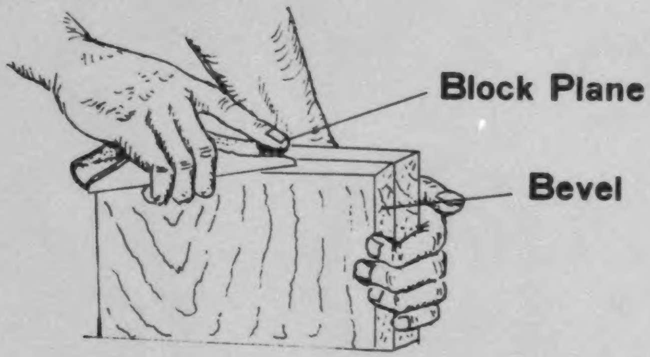


Pressure Is On Knob At Start

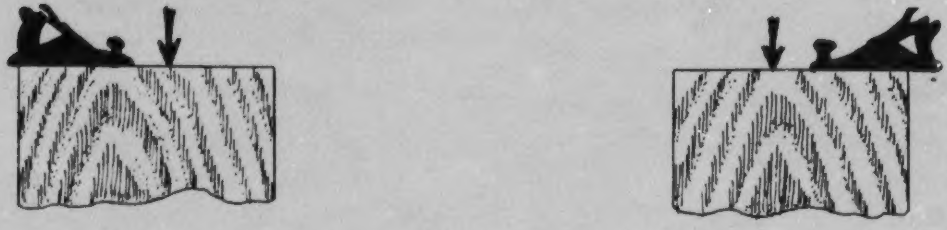
Pressure Is On Handle At Finish


Plane With The Grain
Stop Block

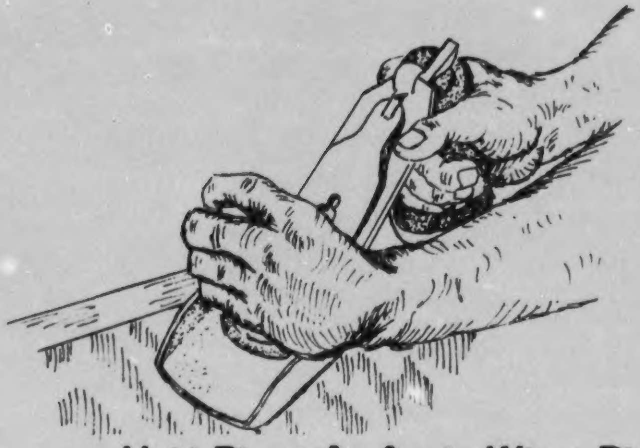
Pressure Is Equalized On Handle And Knob


Block Plane
Bevel

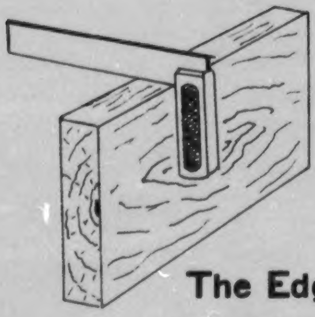
USE OF THE HAND PLANE
CHECKING PLANED WOOD STOCK



When Planing End Grain Plane To Center From Each Side.

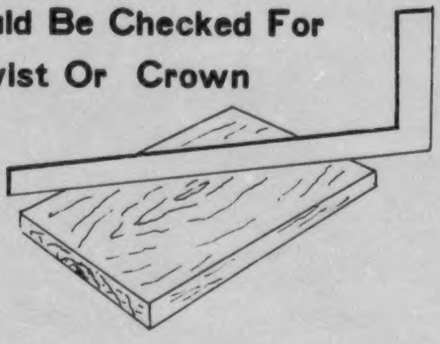


Hold Plane At Angle When Planing End



The Edge And Face Is
Checked For Squareness
While Planing

The Surface Or Face
Should Be Checked For
Twist Or Crown



AGRICULTURAL MECHANICS

Unit B: Farm Carpentry

Topic 3: Identification, Use, and Conditioning of Hand Saws

1. The Importance of Hand Saws

Hand saws continue to be very important tools in a carpentry tool kit or in a well equipped workshop. Crosscut and rip saws are still used for straight sawing in certain types of woodwork construction projects. If there is a limited amount of cut-off and ripping work to be performed, the hand saw may be preferred over the power saw. Working in close places may require the use of a hand saw. It may be advisable to select the proper hand saw for cutting molding, base boards, and facing materials instead of selecting a power saw for such work. Other reasons for using the hand saw are: power may not be available, work can be completed faster on some jobs, and work is easier when handling light tools in some locations.

2. Six Types of Hand Saws

a. Crosscut Saw - The crosscut saw is the most commonly used of all hand saws for general farm work. Teeth on this saw are shaped to cut across the grain of wood. From perpendicular, the front of the tooth is 15 degrees and the back 45 degrees. The most commonly used crosscut saws have from 8 to 11 teeth per inch of blade. The length of blade varies from 18 to 26 inches. The longest blade is the most popular. Fast and coarse cuts are made with a small number of teeth to the inch. Ten and 11 point saws are used to cut finishing materials such as moldings and door facings.

b. Rip Saw - This saw is used to cut with the grain. The overall angle of rip saw teeth are the same as those of a crosscut saw, but the forward angle is only 8 degrees from perpendicular. Teeth cutting edges are square, and the back angles are 52 degrees. The most popular sizes are 24 to 26 inch blades with 5-1/2 to 7 teeth per inch.

c. Compass Saw - This saw is used to cut curves and circles, starting a cut from a hole bored by a brace and bit, and to cut holes for pipe outlets. The blades taper from back to front. Compass saw blades are 12 to 14 inches in length with 8 teeth to the inch. The shape of the teeth resembles those on a crosscut saw.

d. Keyhole Saw - The keyhole saw is used to saw "cutouts". It may be found as a single blade saw or a nest of saws (one handle with two or three replacement blades). One of the blades is used for cutting metal. This saw resembles the compass saw, but the standard blades range from 10 to 20 inches with 10 to 15 points per inch. Curves, holes, and straight sawing cuts are usually smoother when done with a keyhole saw than with a compass saw.

e. Coping Saw - This saw is designed to cut thin or light wood. It is used to cut curves, for scroll work, and shaping the ends of moldings. Blades of this saw are about 1/8 inch wide and are made of thin metal. The overall length may vary from about 6-1/2 to 7 inches with 15 points to the inch.

f. Backsaw - Backsaws are used to make accurate and smooth cuts. The large backsaw is known as a mitre box saw. They may range in length from about 22 to 30 inches. The width of the reinforced blade varies from 4 to 6 inches. Small backsaws are found in lengths from 10 to 16 inches, and the number of teeth per inch may vary from about 11 to 15. All backsaws and dovetail saws are reinforced the full length down the back edge of the blade.

Transparencies Nos. 1 and 2

3. Proper Use of the Different Types of Handsaws

a. Crosscut Saws

Assuming the material is on sawhorses or in a vise, grip the saw handle and place the index finger forward on the handle.

Place the free hand in a position on the material to be sawed so that the thumb can serve as a guide for starting the blade.

Hold the saw blade so that it is at a right angle to the stock and the saw cutting edge is 45 degrees to the surface being cut.

Start the saw cut by placing it on the waste side of the line and use draw strokes until a starting groove is formed. Maintain the 45 degree angle and take long even strokes as the saw cuts through the stock. If pressure is applied, it should be on the downward stroke.

b. Ripsaw

Use the same procedure when sawing with a rip saw except for changing the angle to 60 degrees.

If the saw is pinched when ripping a long board, use a wedge to spread the pieces apart.

c. Compass and Keyhole Saws

After the stock has been marked, start the cut by either a light forward or backward motion.

Hold the saw in the proper position. For example, if the cut is to be square, the saw blade must be held perpendicular to the stock.

To cut a hole or cut an area out in a stock, first bore a hole and start the cut in the hole.

Cut curves and holes by slightly twisting the handle in the direction of the cut.

When sawing sharp curves and small holes, use the point or pointed part of the saw blade.

d. Coping Saw

Check the blade to determine whether or not the teeth are pointing toward the handle and the blade has proper tension. The blade is more likely to kink if the blade is inserted to cut on the forward stroke.

Hold the stock firmly in a vise, bracket, or saddle in order to make a smooth cut.

Turn the blade in the frame to keep the frame from touching the stock. Usually a quarter of a turn is adequate.

Make long, steady, slow strokes. Fast strokes tend to heat the blade and increase the possibility of kinks.

Release the tension on the blade when the saw is no longer used.

e. Backsaw

Start the backsaw cut in the same manner as a crosscut and ripsaw cut; that is, pull the saw backwards to make the initial cut.

If the saw is used out of the mitre box, the thumb may be used to guide the blade on the line until the saw begins cutting the stock on the forward stroke.

When using a mitre box to cut in either a 90 or 45 degree direction, place the stock in the box nearest the body and use the free hand to hold the stock. The thumb of the free hand is not used to guide the blade, but the index finger is placed along the side of the handle.

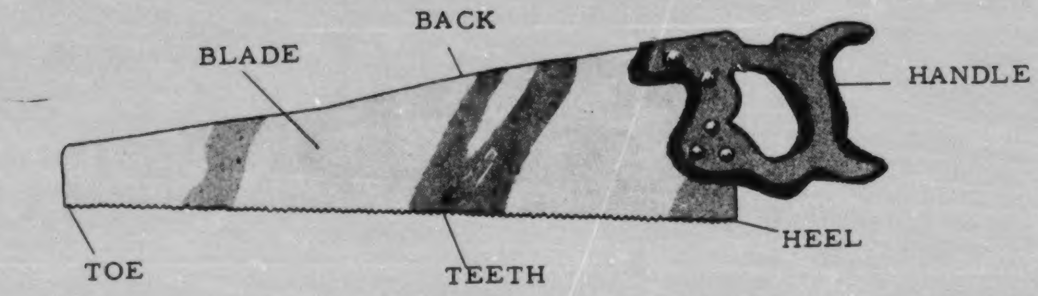
Make long even cuts by holding the blade level on the stock, and use an even pull and push motion.

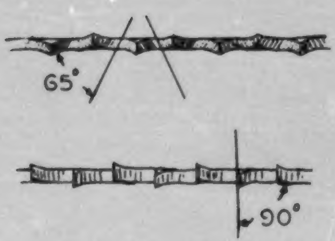
References:

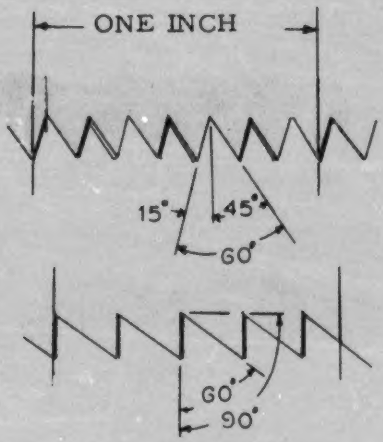
1. Phipps, Lloyd, J., Mechanics in Agriculture, The Interstate Printers and Publishers, Inc., Danville, IL, 1967.

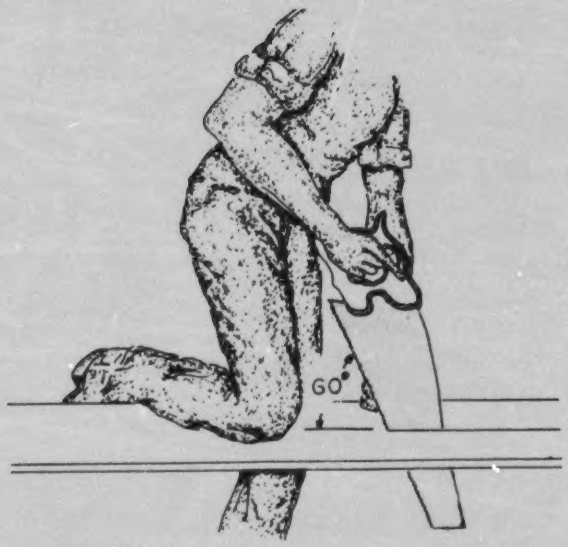
2. Disston Saw, Tool and File Manual, Henry Disston and Sons, Inc., Lacony, Philadelphia, PA

HAND SAWS

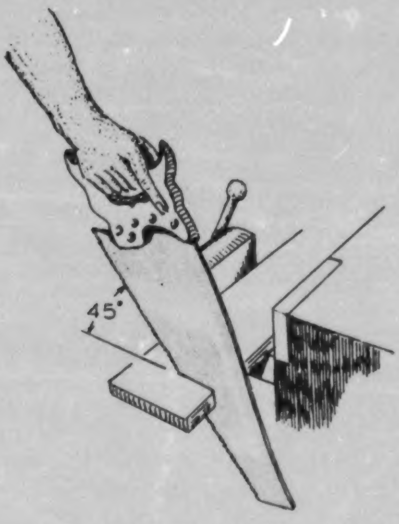

BACK
BLADE
HANDLE
HEEL
TOE
TEETH




ONE INCH
15°
45°
60°
60°
90°

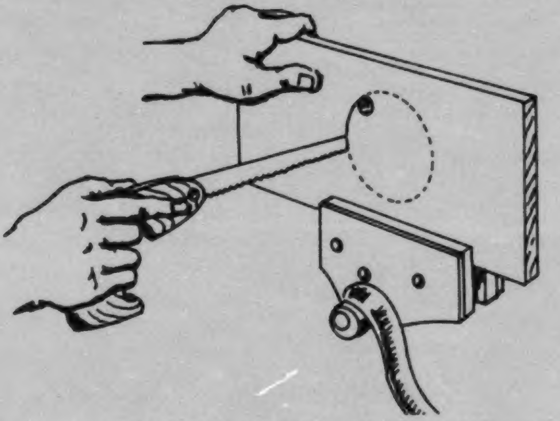


Rip saw

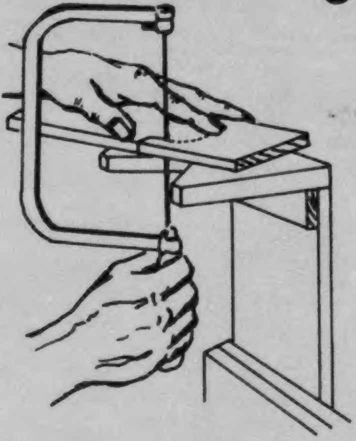


Crosscut saw

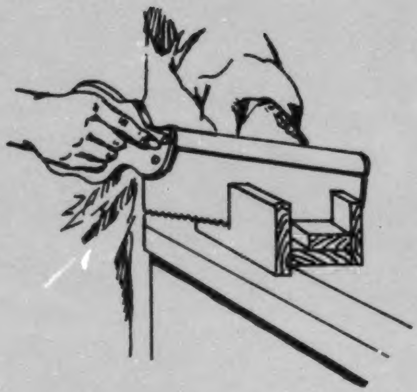
HAND SAWS



COMPASS SAW



COPING SAW



BACK SAW

AGRICULTURAL MECHANICS

Unit B: Farm Carpentry

Topic 4: Wood Chisels

Suggested Procedure and Activities: Exhibits of joints shaped by the chisel and the types of chisels and mallets may be helpful during the discussion.

1. Selection of Wood Chisels and Mallets

a. Wood chisels are selected according to the type of work that is to be performed. Naturally, a 3/4 inch dado work will require a chisel larger than 1/4 inch and smaller than 7/8 inches. A 1/2 to 5/8 inch chisel will permit working room for notching out and smoothing the 3/4 inch dado surface.

b. Wood chisel sizes vary from 1/8 to 2 inches. The length of blade ranges from about 3 to 6 inches. Long lengths are called firmer chisels. Medium lengths are called pocket chisels. Short lengths are called butt chisels.

Transparency No. 1

c. Wood chisels are also classified according to the type of handle attachment.

Socket Chisels - This is the most common type of chisel used in farm carpentry. Due to the handle being fitted into a steel socket, the chisel can withstand harder blows from the mallet. These chisels are used for rough woodwork and framing. The most common sizes are 3/8, 3/4, and 1-1/2 inch.

Tang Chisel - The handle of a tang chisel is similar to that of the socket chisel except that the tang is fitted into the handle. Less driving pressure should be applied to the tang chisel than to the socket chisel. Tang chisels are better for hand work, such as paring, because of their light weight and balance. The tang of a chisel is the spike-like or file-like handle part of the chisel fitted into the handle. This type of chisel usually has a plastic handle.

Transparency No. 2

2. Steps in Making a Cut with the Wood Chisel

a. The board of work should be fastened firmly. A vise is the best method to use for short wood stock.

b. The chisel cut should be made with the grain to prevent the board from splintering or splitting.

c. One hand should be used to guide the chisel blade, and the other hand should be moved slightly from right to left as pressure is applied to the chisel handle.

d. The bevel should face down when making rough cuts, and it should be face up when paring or finishing materials.

e. The first cut over a surface may require the use of a mallet, whereas the finishing cut of the same work should be done by hand. This method of chisel cutting is used mainly for making joints.

3. The Different Uses of the Wood Chisel

Transparencies Nos. 3 and 4

a. Dado Trimming

Wide dadoes should be cut several times with the saw and the large portion of the material removed by the mallet and chisel.

Trimming should be half way from each edge of the cut and at the same time in an upward direction. The center should be trimmed last.

b. Notch Edge Trimming

After the notch is marked out accurately several cuts should be made with the saw.

The larger portions should be removed with the chisel and mallet.

Trimming or smoothing should be made in the same way as the dado cut.

c. Curve Trimming

An outside or convex curve can be finished with a wood chisel after about three straight cuts are made along the curve line.

The chisel bevel should be up while trimming around the curve.

Inside curves should be trimmed with the bevel down. Most inside curves are usually first cut with a sabre or keyhole saw.

d. Paring Chamfers or Cutting a Bevel

Chisels are used similarly to a plane to make a slight bevel on a board. The bevel side is up when making a cut.

To prevent splitting, the bevel should be made with the grain first, then followed by working the chisel at an angle along the end grain.

e. Mortise-and-Tenon Joint

The area is marked off for a mortise according to the size of tenon to be used (mortise is a hole cut into a board, and a tenon is the cut that is inserted into the mortise).

A brace and bit can be used to cut out the tenon area, leaving shaping-up for the chisel, or the chisel can be used to make the entire cut.

The rough work is made with the mallet whether or not a brace and bit are used, and the trimming or finishing is done by hand, without the use of the mallet.

f. Trimming End Grain of a Dado

The flat surface of the chisel should be on the end grain at an angle and the handle brought upward as the cut is made.

The flat side of the chisel should leave a cut equal to the original end grain cut.

g. Rabbet Trimming

Rabbeting requires the use of several saw cuts if the second piece of board is large. (A rabbet is a groove cut into the edge or end of a board to receive another board.)

Chiseling may be used for finishing. Chiseling a rabbet joint is similar to chiseling a dado; the flat side is held against the board surface.

h. Installing Butt Hinges with a Chisel and Mallet

The area is marked off according to the hinge size.

The wood is chiseled out by leaning the chisel slightly toward the flat side and tapping it with the mallet.

The area is trimmed out without the use of the mallet by working the chisel with the flat surface against the cut.

4. The Common Wood Joints that may be Trimmed by Use of the Wood Chisel

Dado
Mortise-and-Tenon
Rabbet
Cross lap
Middle lap
End lap
Mitre
Half lap

5. Care of the Chisel While in Use

The chisel should be laid on a table with the bevel down to protect the cutting edge.

The wood chisel should be kept sharp and the cutting edge protected from all metal.

A chisel, like all other tools, has a certain purpose and should be used for that purpose. It must not be used to pry open containers, used as a screwdriver, and the hammer should never replace the mallet to drive the chisel.

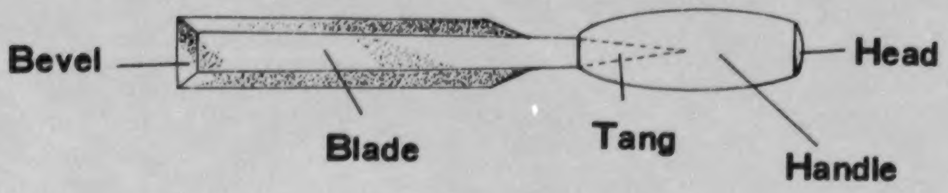
References:

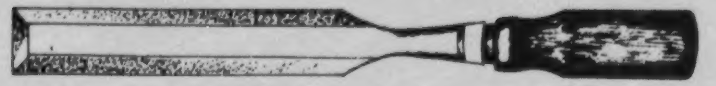
1. Durbahn, Walter E., Fundamentals of Carpentry Tools, Materials, and Practices, Volume I, American Technical Society, Chicago, IL, 1971.

2. Phipps, Lloyd J., Mechanics in Agriculture, The Interstate Printers and Publishers, Inc., Danville, IL, 1967.

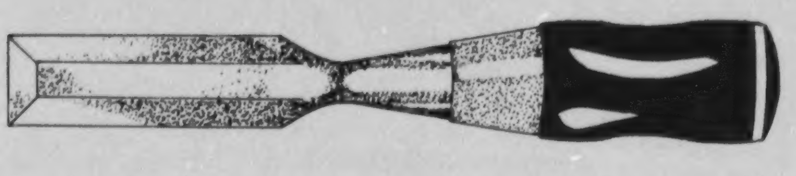
PARTS AND TYPES OF WOOD CHISELS

Parts of a Wood Chisel

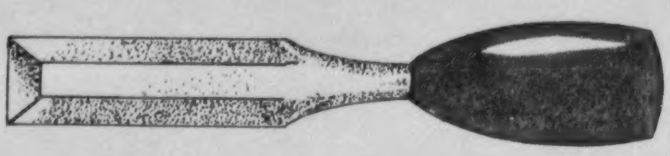

Bevel
Blade
Tang
Handle
Head



A Socket Chisel With A Wood Handle

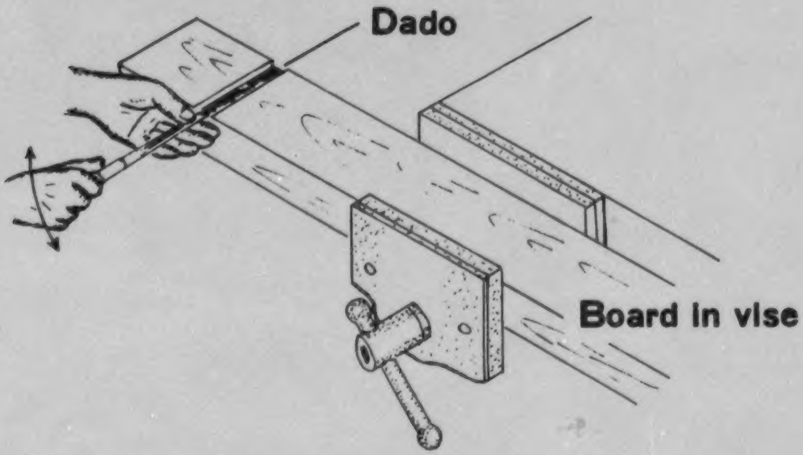


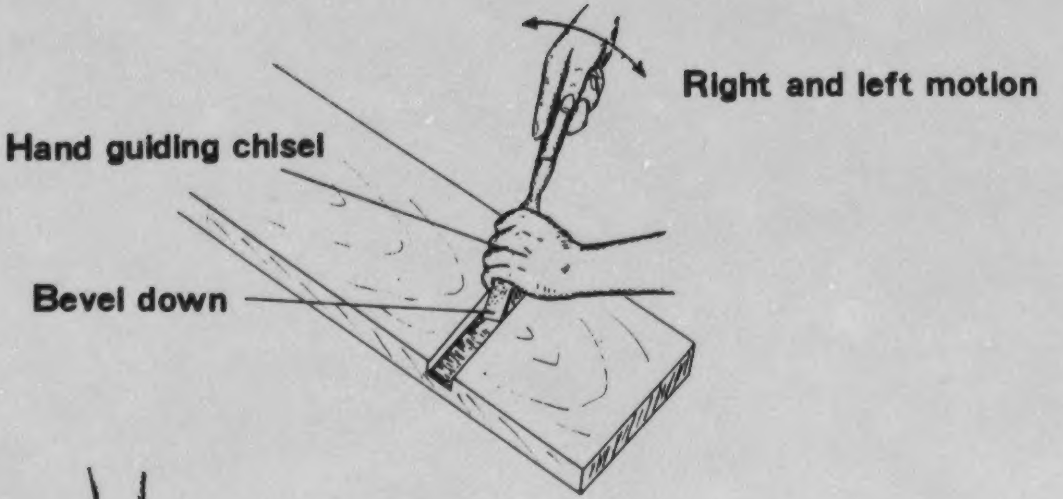
A Socket Chisel with a plastic handle

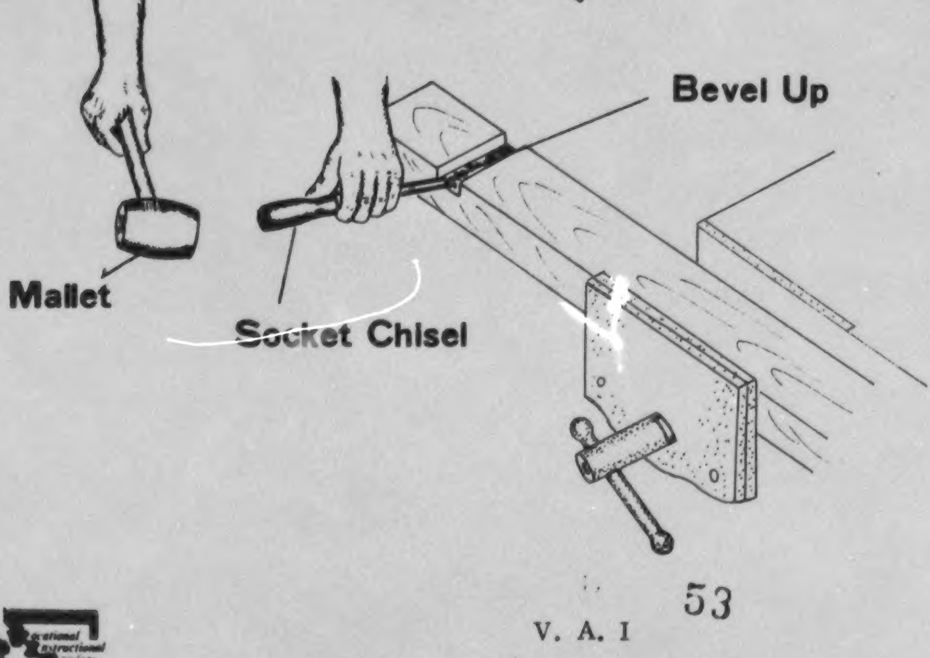


A Tang Wood Chisel

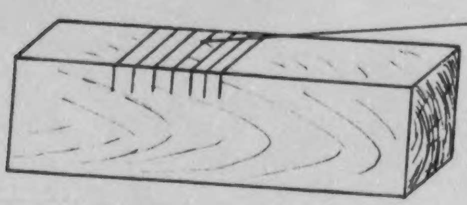
STEPS IN CUTTING WITH A CHISEL


Dado
Board in vise

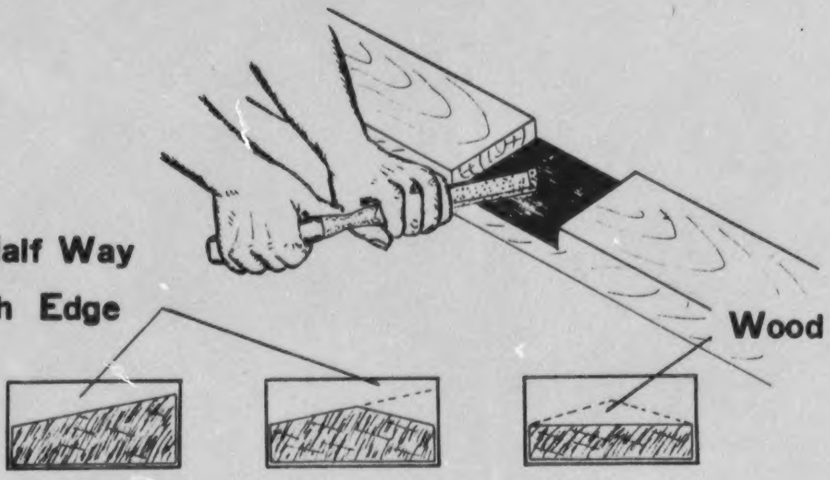

Right and left motion
Hand guiding chisel
Bevel down


Bevel Up
Mallet
Socket Chisel

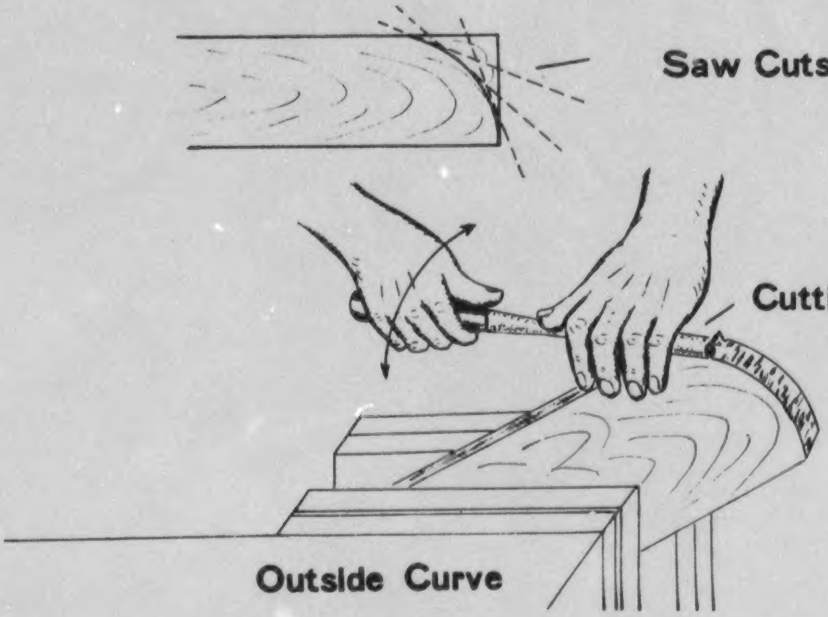
DADO, NOTCHING AND CURVE CUTTING


Several Saw Cuts

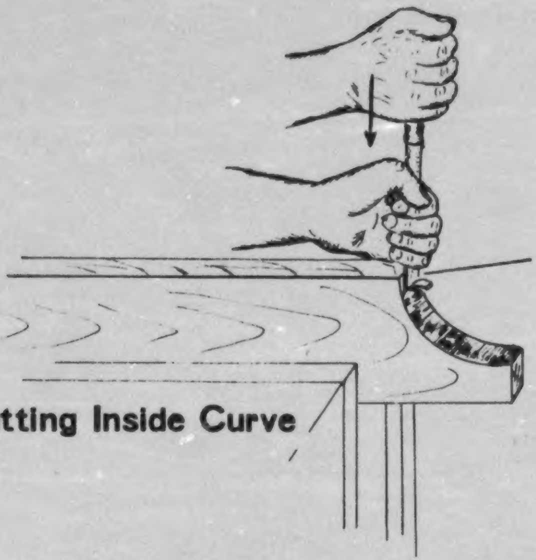
Edge And Dado Cut

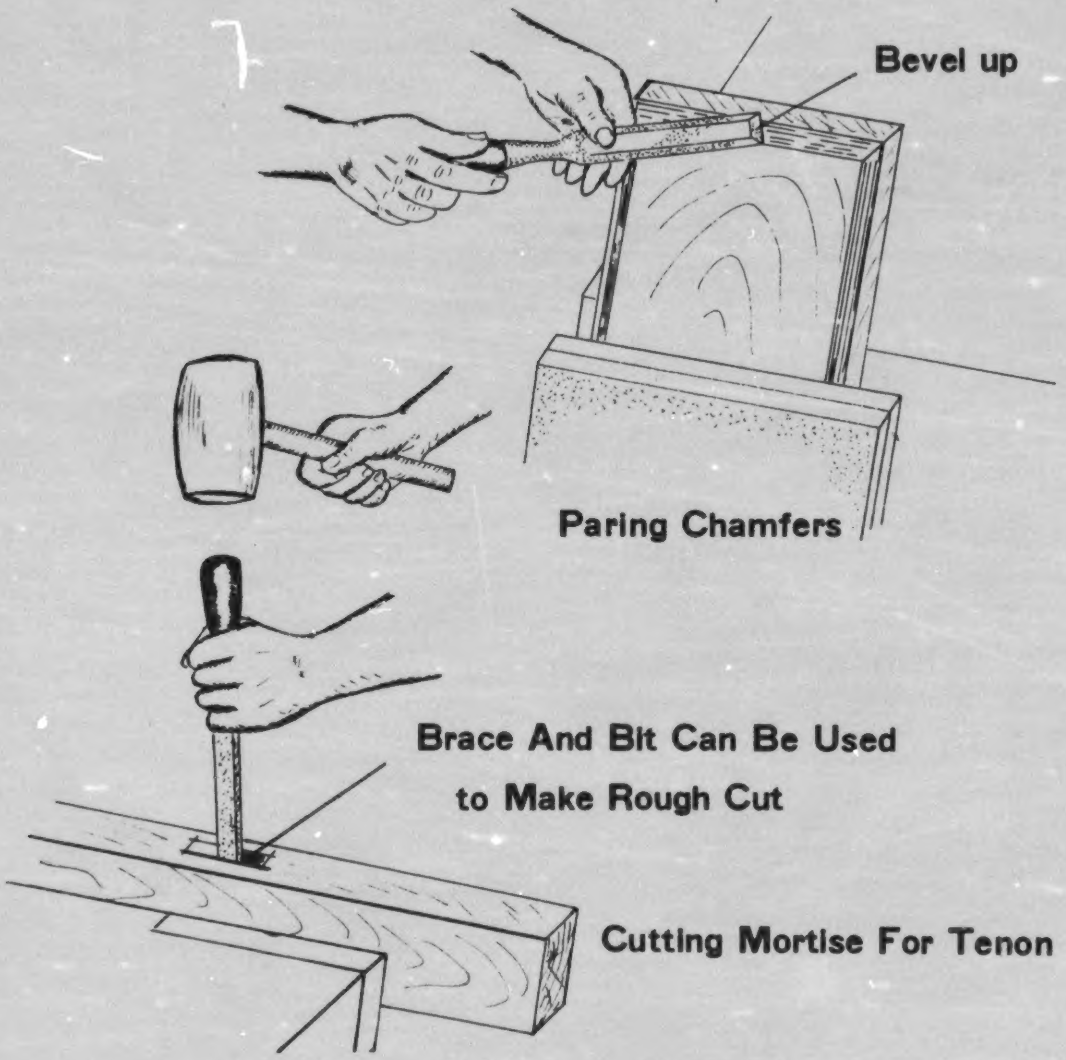

Trimming Half Way
From Each Edge
Wood Removed Last

Trimming Dado


Saw Cuts
Cutting With The Grain
Outside Curve

INSIDE CURVE, PARING AND MORTISE-AND-TENON


Bevel Down
Cutting Inside Curve


Bevel up
Paring Chamfers
Brace And Bit Can Be Used
to Make Rough Cut
Cutting Mortise For Tenon

Vocational Instructional Services
Agricultural Education

V-B-5
Basic V. A. 1
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AGRICULTURAL MECHANICS

Unit B: Farm Carpentry

Topic 5: Brace and Bits

Suggested Procedure and Activities: Except for the transparency on the parts of a brace and bit, a demonstration of the use of a brace with the different types of bits may be the best teaching aid.

Transparency No. 1

1. Selecting the Brace

The two-jaw chuck brace is equipped to handle the seven major types of bits discussed in this lesson. The chuck clamps the square shank bit by the bit tang to hold it firmly in place.

Braces range in size from about 6 to 14 inches. The size is determined by the brace swing or sweep, that is, the distance across the diameter of the circle made by a complete sweep of the handle. A 10 inch sweep brace is most commonly used to do average work.

The ordinary brace without the ratchet may cost less than the ratchet brace, but its functions are limited. The ratchet permits the boring of holes in places where a full handle turn cannot be made due to obstructing objects. The ratchet works both ways, forcing the bit forward or backward. It can also be set so that the handle will not swing free in the operation.

Corner braces are equipped with two handles and a head. It is used for boring against walls and in corners.

Transparency No. 2

2. Selecting the More Common Types of Bits

The auger bit is used for boring holes in wood. The tang on the shank is usually square, depending on the type of brace used. Auger bits range in size from 3/16 inch to about 2 inches. A No. 11 bit will bore a hole 11/16 inch in diameter. The figure 11 is found on the shank. Auger bits are usually found in sizes from 1/4 inch up to 1 inch, graduated in one-eighths of an inch.

The expansive bit is used to bore holes ranging from 1 to 3 inches in diameter. The blade or cutter may be adjusted for different sizes of holes. The expansive bit is similar to the auger bit in that is has a feed screw that draws the bit into the wood. It has only one lip; therefore, it must be held straight.

The forstner bit is also used on wood. It can be used to bore holes for dowel pins and countersinking washers that are used with bolts on wood. The sizes range from 1/4 inch to 2 inches in diameter.

The twist drill bit, which is sharpened with the same angle as the round shank bit for metal, is used for both metal and wood boring. The more pointed bit stock or twist drill is used for wood only. The sizes may range from 1/16 inch to 1-1/4 inches in diameter.

Screwdriver bits are used to set or loosen screws or bolts with slotted heads. The size is determined by the width of the bit blade. The widths range from 3/16 inch to over 1/2 inch.

Countersinks are used to widen the space at the hole entrance for oval or flat head bolts or screws. The head of the screw or bolt is set flush or slightly below the surface. The size is determined by the diameter of the cut made by the largest part of the bit.

Gimlet bits are used to make holes for screws in wood. The bit point forms the tapered hole. They vary in size from 1/8 inch to 3/8 inch in thirty-seconds.

A lock set bit is used to make holes for cylindrical locks. This type of bit is usually used with a lock jig.

Transparency No. 3

3. Placing the Bit in the Brace and Setting the Ratchet

Grasp the chuck shell and brace handle; holding the chuck in an upward position, turn the handle to the left until the chuck jaws are open.

Place the bit in the jaws of the chuck and turn the handle to the right.

Check the bit as the jaws of the chuck are tightened on the tang. The bit must be held firmly between the jaws while it is in use.

When boring a hole in a corner, or some obstruction prevents the full turn of the brace handle, the ratchet should be adjusted as follows:

With the bit pointed in an upward position, the cam ring should be turned to the right to permit the bit to turn to the right for boring a hole.

If the cam ring is turned to the left the ratchet action will be to the right, and the bit can be withdrawn from the wood.

Transparency No. 3

4. How to Start the Hole by Using the Brace and Bit

Steps in starting the auger bit include:

a. Mark the location of the hole center by crossed lines.

b. Start the hole with a sharp pointed tool (awl or ice pick).

c. Grasp the lower part of the bit (twist) and place the hand against the board; at the same time insert the point of the bit into the hole at an angle.

d. Raise the bit until it is at a right angle with the work.

e. Test to see that the hole is being bored squarely by:

Sighting the bit at right angles.

Comparing the bit with the nearest straight edge. The sides of the bench vise that holds the material may be used as a straight edge.

Using a try-square near the bit.

Transparency No. 4

5. Boring the Hole

a. Applying Pressure on the Brace

Pressure is applied by one hand when boring a vertical hole. Usually, the left hand is used to put pressure on the head of the brace.

When boring a horizontal hole, the left hand is placed over the brace head, and the thumb and forefinger are placed around the quill. The stomach puts pressure against the left hand.

b. How to Prevent Splintering, Splitting, and Making a Counterbore

When boring a hole through a board, splintering can be prevented on the second face by stopping when the screw point is felt. The auger bit point should be entered in the point hole on the second face to complete the hole.

It is best to clamp a board to the second face piece of material when using an expansive bit.

Splitting is prevented when drilling large holes in thin or narrow pieces of wood by either placing the piece in a vise so that the jaws protect the edges or by first boring the hole with a small twist drill and then drilling with a larger twist drill.

When countersinking for bolt or screw heads, the hole should be made before the counterboring.

Transparency No. 4

6. Determining the Proper Depth When Boring a Hole

Methods to use when boring holes to a certain depth are:

a. Wooden Stop - A small block of wood center bored, with the bit projecting from the block to the desired depth of the hole, is most satisfactory.

b. Metal Bit Stop - This type of bit stop is attached to the bit by a wing nut. It can be moved up and down the bit twist.

After the cutting lips touch the wood, a rule will show the distance from the wood surface to the chuck. Measurements can be made as the hole is being drilled. If several holes of the same depth are to be made, it is best to use a block cut to fit under the chuck.

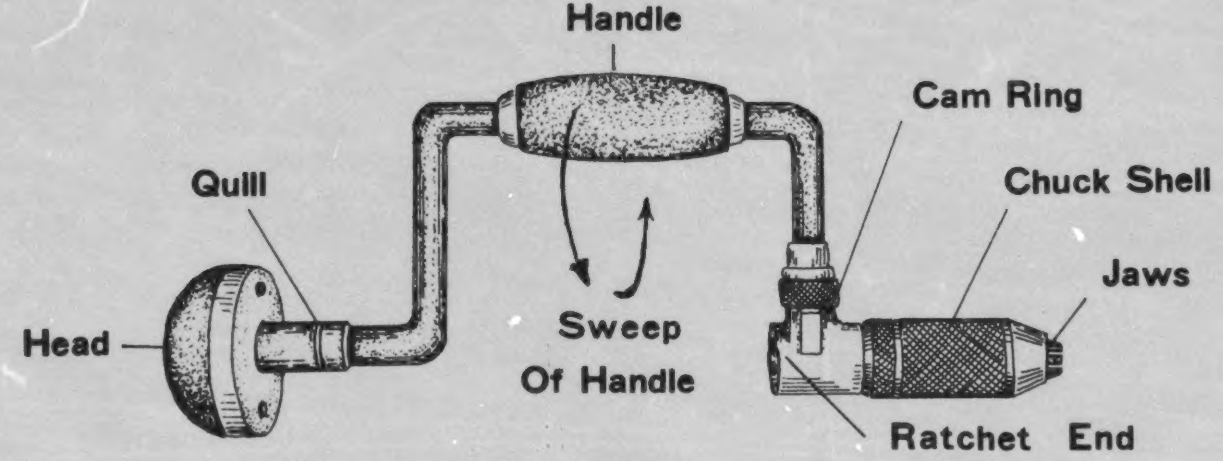
References:

1. Durbahn, Walter E., Fundamentals of Carpentry, Tools, Materials, and Practices, Volume I, American Technical Society, Chicago, IL, 1971.

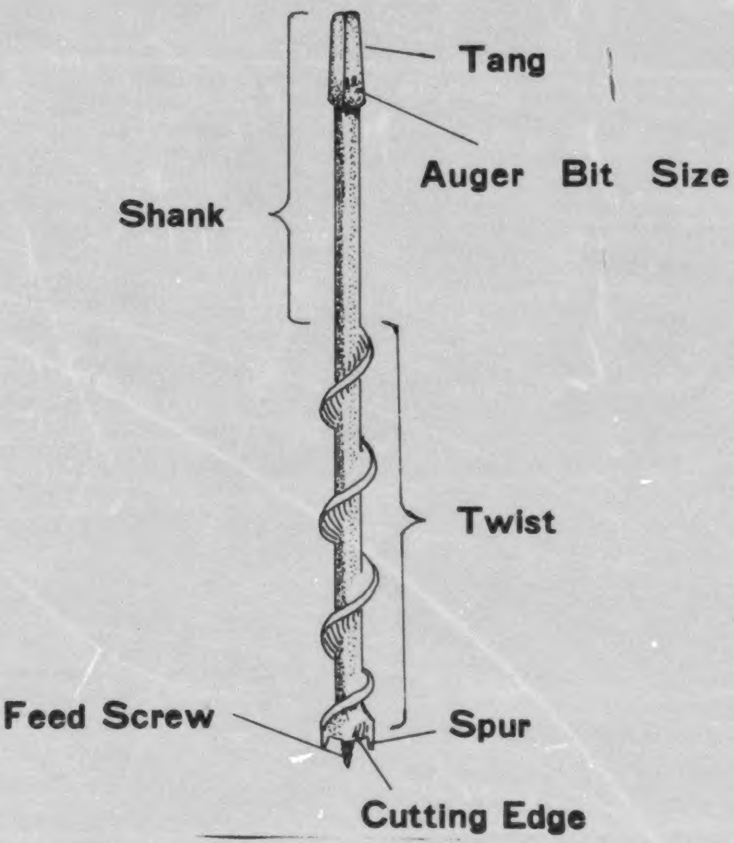
2. Foss, Edward W., Construction and Maintenance for Farm and Home, John Wiley and Sons., Inc., New York, NY, 1960.

3. Wakeman, T. J. and Vernon Lee McCoy, The Farm Shop, The Macmillan Company, New York, NY, 1960.

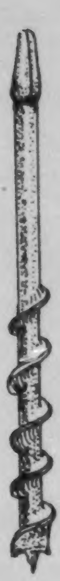
PARTS OF THE BRACE


Handle
Cam Ring
Chuck Shell
Quill
Jaws
Head
Sweep
Of Handle
Ratchet End

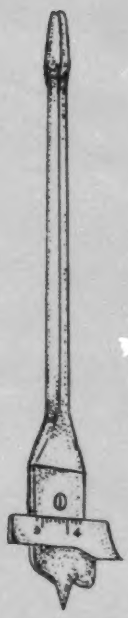
PARTS OF THE AUGER BIT


Tang
Auger Bit Size
Shank
Twist
Feed Screw
Spur
Cutting Edge

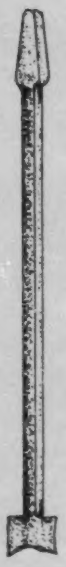
TYPES OF BITS



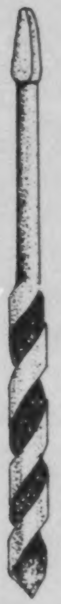
Auger



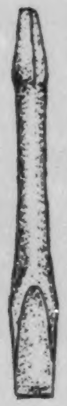
Expansive



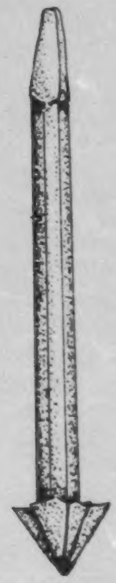
Forstner



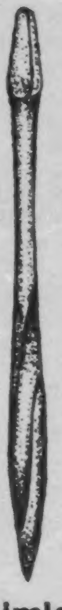
Twist



Screw Driver

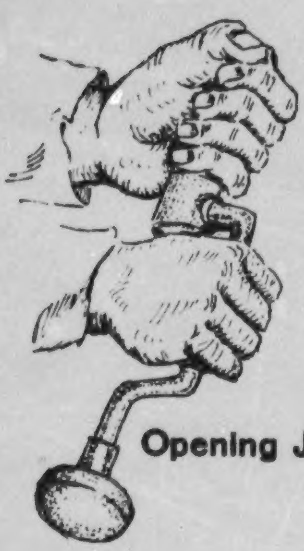


Countersink

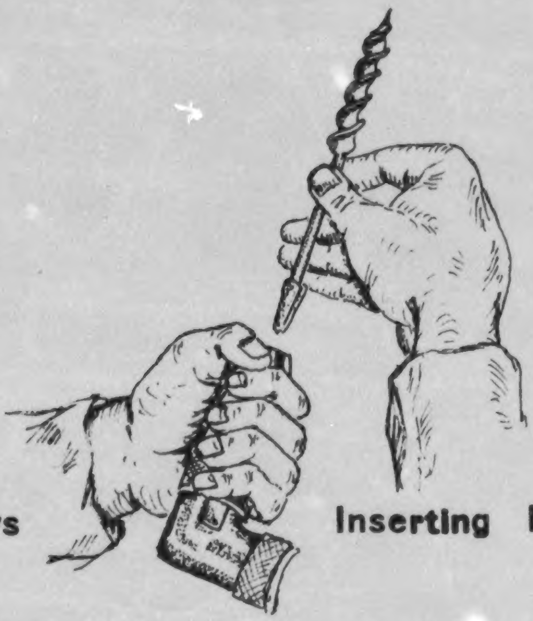


Gimlet

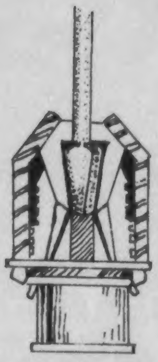
PLACING THE BIT IN THE BRACE



Opening Jaws

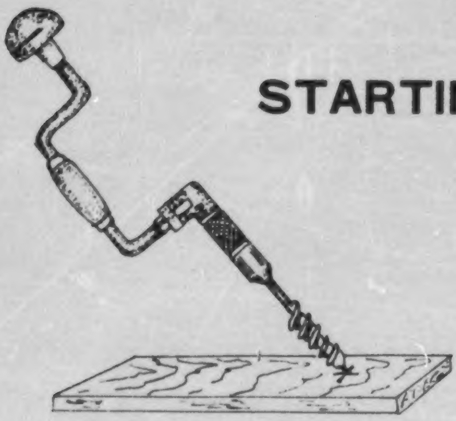


Inserting Bit

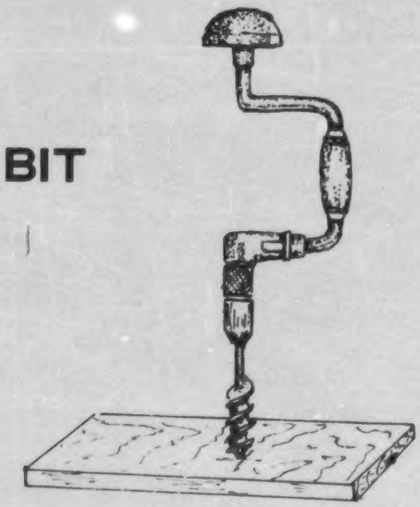


Bit Firm In Jaws

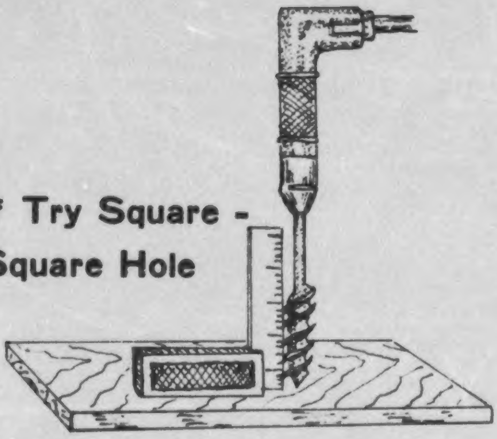
STARTING THE BIT



Point Of Bit At Cross Marks

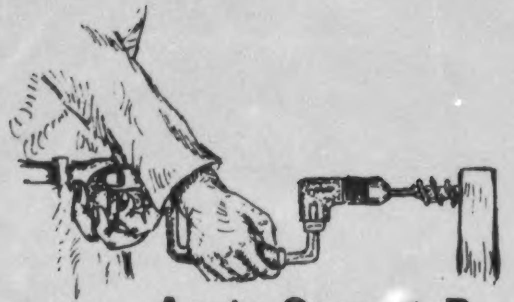


Bit At Right Angle

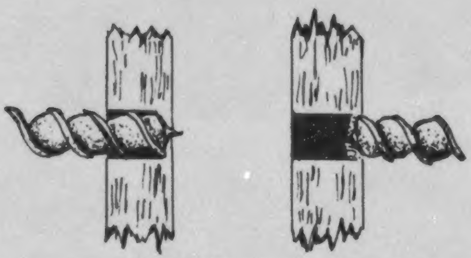


Use Of Try Square -
Boring Square Hole

BORING A HOLE THROUGH A BOARD

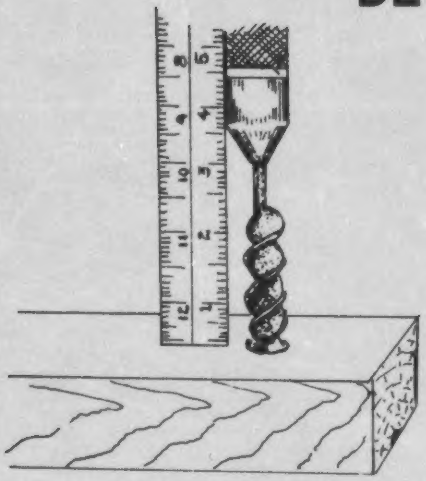


Apply Correct Pressure

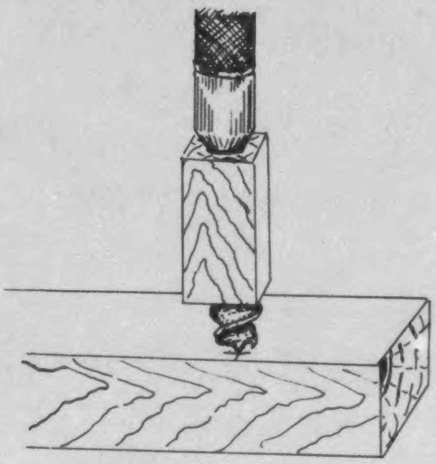


Reversing Bit To Prevent Splintering

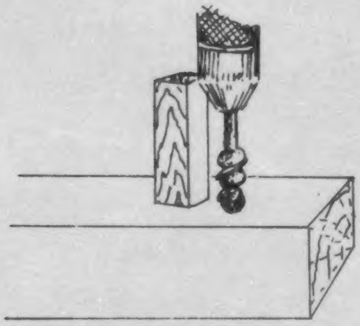
DETERMINING DESIRED DEPTH



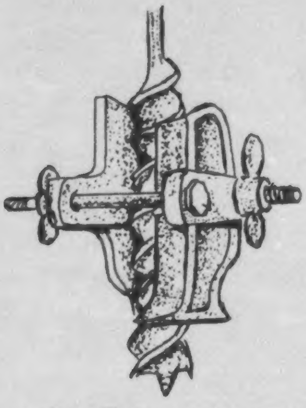
Use Of Rule For Proper Depth



Use Of Block For Depth



Outside Block For Depth



Use Of Depth Gauge

AGRICULTURAL MECHANICS

Unit B: Farm Carpentry

Topic 6: Hand Drills

Suggested Proceduresand Activities: The types of hand drills and drill bits from the agricultural mechanics shop may be used as teaching aids during the discussion.

Transparency No. 1

1. Types of Drills Operated by Hand and Their Purposes

   a. The three major types are:

      Hand drills
      Breast drills
      Push drills
      Hand operated drill press (not a major type)

   b. Hand drill purposes include:

      Drilling small holes, either in wood or metal, 1/4 inch or less in diameter.

      Form holes or openings for screws, nails, bolts, and other materials where openings are necessary.

   c. Push drills are used mainly to bore holes for small screws in wood and other soft materials. A push drill is made to bore a hole less than 1/4 inch in size. Most push drills have a set of bits ranging from 1/16 to 11/16 in size stored in the handle. This drill may be operated by one hand while the other hand is left free to support the work.

   d. Breast drills are designed for heavier work than either hand or push drills. They are usually constructed with adjustable handles and two speeds. The drill is made to bore a hole up to 1/2 inch. The breast drill is for general purpose work in metal and wood.

   e. The hand powered drill press was one of the oldest types of heavy duty drills. A large wheel was turned with one hand as the other hand pressed the drill into the stock being drilled by using a lever. In some cases the hand operated drill press exceeded 1/2 inch capacity. Holes in both metal and wood could be bored with the hand operated drill press.

2. General Characteristics of the Drill Parts

a. Chuck (has three jaws) holds the bit in place.

b. Pinion is the small gear attached to the main frame which is turned by the speed gear.

c. Crank handle is attached to the speed gear on hand and breast drills.

d. Handle is the top part of the main frame held by the hand when operating the drill.

e. Speed gear turns the pinion gear and pinion idler on the hand drill. A breast drill may have only the pinion gear.

f. Frame supports gears, handles, and chuck.

g. Side handle is located opposite the speed gear on a hand drill and above the chuck on a breast drill.

h. The push drill is made up of a chuck, chuck sleeve, spiral spindle, locking ring, and handle.

i. The breast drill has a breast support or plate,whereas the other two drills have handles. Most hand drills and push drills have magazine handles (they hold bits).

Transparency No. 2

3. Inserting and Removing the Bit

a. Hand drill bits are inserted in the following manner:

Hold the chuck and turn the crank backward to open the jaws slightly larger than the bit diameter.

Center the bit and tighten the chuck by holding it firmly and turning the crank forward.

The bit is removed by holding the chuck and turning the crank backward.

b. The procedure to insert and remove the bit from the breast drill is the same as that of the hand drill.

c. The push drill chuck sleeve is pushed forward to insert the bit. It is also pushed forward to release the bit.

Transparency No. 3

4. The Proper Way to Use a Drill

a. The hand drill should be held firm and steady while in use, regardless of the angle it is used on the work.

b. The handle of the hand drill may be held against the body, releasing the hands for the crank and side handles. This is the way a breast drill is used.

c. An even pressure should be exerted on the handle or handles. The crank should be turned at a steady speed and not too fast.

d. The push drill is used with one hand placed on top of the handle. The return spring causes the drill to unwind on the backward stroke, which helps clean the hole and forces the bit into a cutting position.

e. The steps to follow when drilling a hole are:

The center of the hole should be marked with an awl or similar tool for drilling soft material and with a center punch for metals.

Select a drill bit of the proper size (the diameter of the cutting part may be slightly smaller than the large part of the screw or bolt for soft materials, and it should be the same size for metal materials).

The stock being drilled should be held firmly, either in a vise or by other means.

On metal, a drop or two of oil should be used at the place of drilling.

The pressure should be eased as the drill breaks through the surface.

A small pilot hole made by a small bit is necessary in forcing a larger bit through certain woods or metals.

To drill to a certain depth, a depth gauge may be made from a piece of wood. The piece of wood is drilled and slipped over the bit.

To clean a drilled hole, the bit should be turned in the drilling position as it is withdrawn from the stock. The bit should be removed frequently during the drilling process to clean the hole.

5. Drill Bits with Round Shanks

a. Types of drill bits are:

Drill points for push drills range in size from about 1/16 to 11/64 inch.

Twist drills are used for metal and wood drilling. They are found in sizes measured by 1/64 inch units.

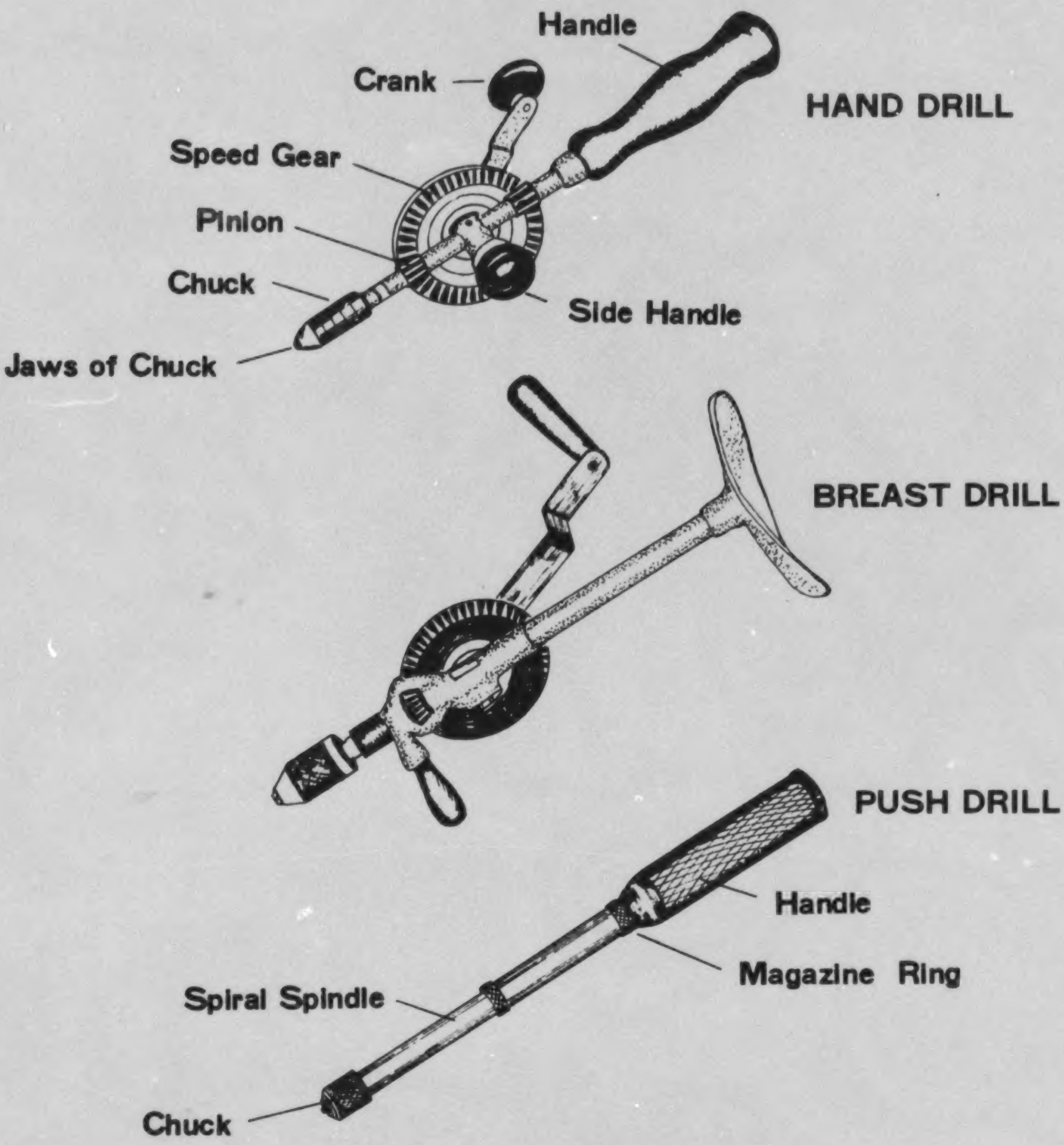
b. Usually hand drilled holes are less than 1/4 inch in diameter, and breast drilled holes rarely exceed 1/2 inch in diameter.

References:

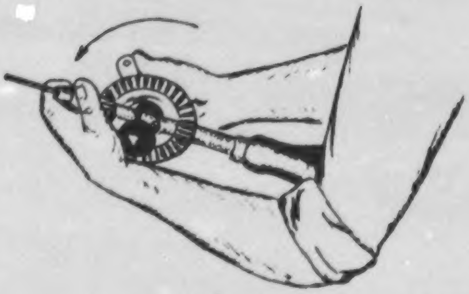
1. Durbahn, Walter E., Fundamentals of Carpentry Tools, Materials, and Practices, Volume I, American Technical Society, Chicago, IL, 1971.

2. Phipps, Lloyd J., Mechanics in Agriculture, The Interstate Printers and Publishers, Inc., Danville, IL, 1967.

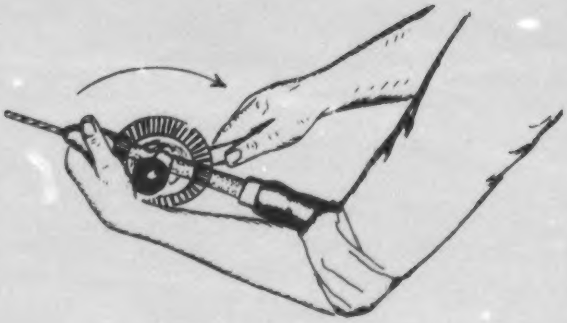
TYPES OF DRILLS AND PARTS


Handle
Crank
HAND DRILL
Speed Gear
Pinion
Chuck
Side Handle
Jaws of Chuck
BREAST DRILL
PUSH DRILL
Handle
Magazine Ring
Spiral Spindle
Chuck

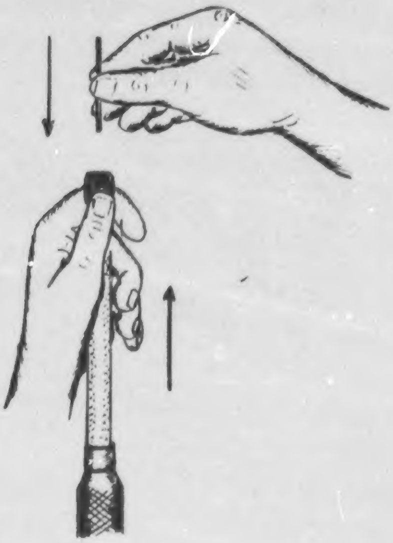
INSERTING AND REMOVING DRILL BITS



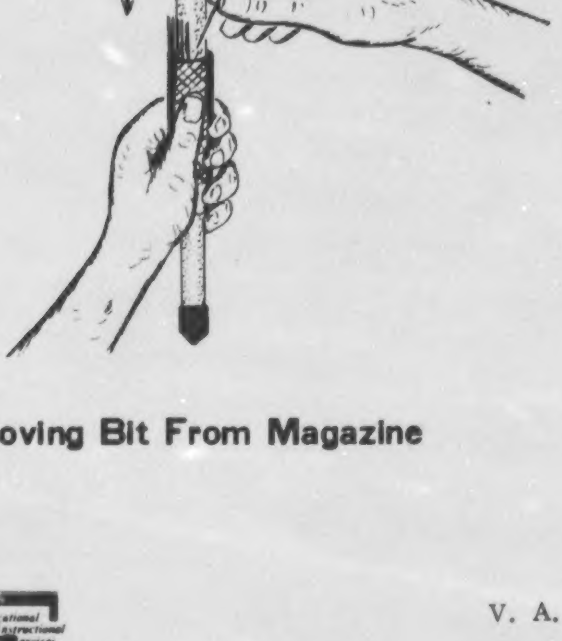
Inserting Bit



Removing Bit

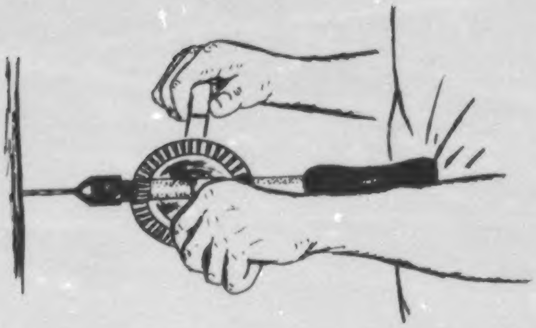


Inserting or Removing Bit

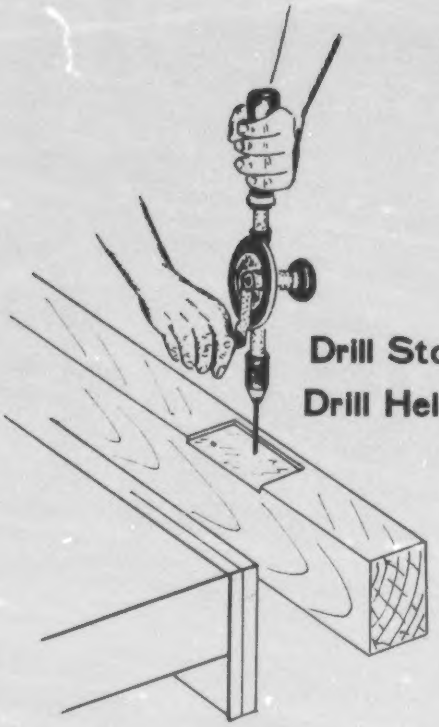


Removing Bit From Magazine

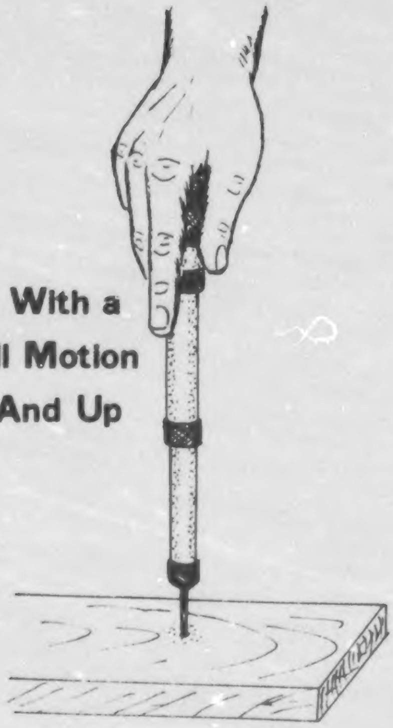
USE OF HAND DRILLS



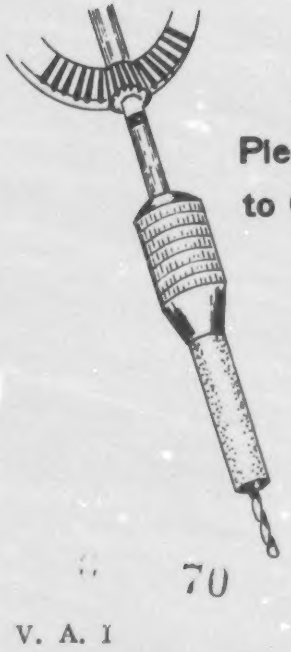
Pressure of Body Used on Hand Drill



Drill Stock And Drill Held Firmly



Drilling With a Push Drill Motion Down And Up



Piece of Wood Used to Gauge Depth of Bit

Vocational Instructional Services
Agricultural Education

V-B-7
Basic V. A. 1
Agdex 016 x 783

AGRICULTURAL MECHANICS

Unit B: Farm Carpentry

Topic 7: Screwdrivers

Suggested Procedures and Activities: An exhibit of screwdrivers, screws, and pilot holes may be used during the discussion.

1. Selecting Screwdrivers

Transparency No. 1

a. The types of screwdrivers and their major parts are:

Standard or common
Phillips
Offset
Spiral-ratchet
Screwdriver bit

The standard screwdriver has five major parts.

Head
Handle
Ferrule
Blade
Tip

The spiral-ratchet parts:

Handle
Ratchet
Spiral
Chuck
Bits

Transparency No. 2

b. Standards screwdrivers are usually from 1-1/4 to 18 inches in length. The handles are either made of plastic or wood with a blade that extends through the entire length of the handle. Screwdriver bits for braces are about 5 inches long and their tips are 1/4 to 1/2 inch wide. Spiral ratchet screwdrivers are available with several different types of blades.

A screwdriver should be selected according to the type of work to be performed.

A long-bladed screwdriver is easier to use than one with a short blade if enough space is available to work with it.

The standard screwdriver tip should be square and no wider than the screw head. The tip should fill the screw slot. The Phillips tip must fit the screw slot.

c. Results encountered when selecting an improper screwdriver for the job are:

The tip will scar the wood around the head of the screw if it is too wide.

If the tip is curved it will mar both the screw and wood. The screwdriver cannot be kept in the screw slot.

Screwdrivers that are too short are difficult to use because the tip cannot be kept in the screw slot if the handle is not kept in line.

A small tip should never be used on a large screw; the screwdriver tip, screw slot, and the surface of the material may be damaged.

A tip that is too large for the screw slot will damage the screw and the surface of the material if it is forced into the screw slot.

Transparency No. 3

2. Using the Different Types of Screwdrivers

a. Standard Screwdrivers - The hand is placed in the palm of one hand and the blade is guided with the other hand by holding it near the tip. The blade is kept parallel with the screw or bolt as it rotates. The hand near the tip keeps the tip square on the screw head as a new grip is placed on the head or handle.

b. Spiral-Ratchet Screwdrivers - This screwdriver can be used in awkward places for driving or drawing screws. One hand is placed on the handle without releasing the grip. The other hand is placed on the chuck. The handle is pushed straight.

c. Screwdriver Bit - This bit may have a tapered or round shank. If it is used with a ratchet brace, a quarter or half turn will keep the bit from slipping in the screw slot. Pressure and balance are supplied by both hands on the brace when driving a screw into the wood. Large screws can be driven more easily with bits than with the standard screwdriver.

d. Phillips Screwdrivers - This screwdriver has a special slanted tip that is cross-shaped to fit into a Phillips cross-shaped screw slot. The driving method is the same as for the standard screwdriver.

e. Offset Screwdrivers - The offset screwdriver is used to drive screws in close places where other types of screwdrivers cannot be used. There is a short blade on each end, bent in the opposite direction and at right angles to the handle. One of the blades is in the same plane as the handle. Usually it is necessary to use both ends in driving a screw.

3. Steps to Consider in More Efficient Use of the Screwdriver

a. Bore the first hole as near the size of the screw shank as possible in the first piece of material.

b. Bore the second hole slightly smaller than the screw root but only half the distance of the threaded part for soft wood.

c. Countersink screw heads for flat and oval head screws. The countersink should equal the diameter of the screw head, and it should be in the larger hole.

If a round-head screw is sunk below the surface, a twist drill may be used instead of a countersink. The screwdriver blade should be small enough not to damage the counterbore or surface. Flat head screws are used when plugs or dowel are inserted above the screw head.

Where very hard wood is fastened together, it may be necessary to bore a second (anchor) hole the length of the screw threads. Soap, oil, or water will make the screw enter more easily in hard wood.

Holes for very small screws can be made with an awl or other sharp, pointed instrument. This practice makes it easier to use the screwdriver.

Screws can be tapped lightly with a hammer only to set the screw in a small pilot hole before driving it into the wood. Note: A heavy blow with the hammer will mar the screw head, and if driven too deeply with the hammer, the thread-holding effect will be reduced.

4. Misuse of the Screwdriver

a. The screwdriver is not a pry tool; therefore, it should not be used to replace such a tool.

b. Even though the screwdriver blade is bradded on top of the handle or permanently set in a sturdy handle, it should not be used as a chisel, nor should a hammer or mallet be used on it.

c. Screwdriver blades are usually either round or square. If a screw is hard to withdraw or set, pliers and wrenches should not be used on the blade to give the screwdriver extra power. The screw head may be sheared off or the tip of the screwdriver broken.

d. In some cases screwdrivers are used as mixing tools for paints, glues, and oils. Unclean tips will slip out of the screw slots; therefore, they should not be used as a mixing paddle.

References:

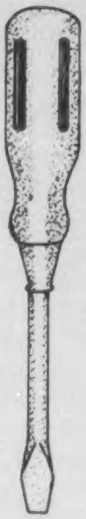
1. Durbahn, Walter E., Fundamentals of Carpentry Tools, Materials, and Practices, Volume I, American Technical Society, Chicago, IL, 1971.

2. Phipps, Lloyd J., Mechanics in Agriculture, The Interstate Printers and Publishers, Danville, IL, 1967.

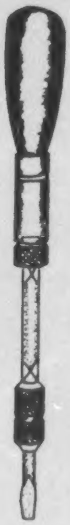
3. Wakeman, T. J. and Vernon Lee McCoy, The Farm Shop, The Macmillan Company, New York, NY, 1960.

4. "Stanley Tool Guide," Stanley Tools, New Britain, CT.

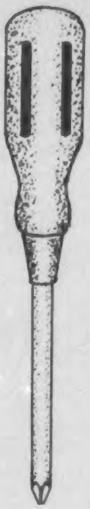
TYPES OF SCREW DRIVERS



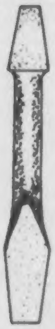
Standard



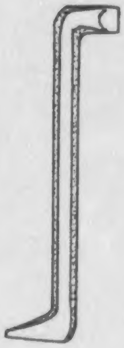
Spiral-Ratchet



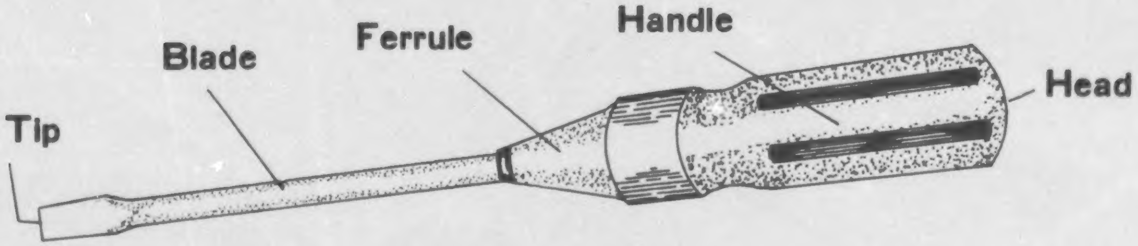
Phillips



Screw Driver Bit

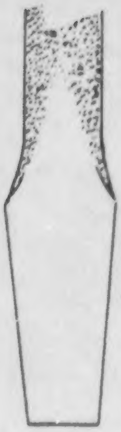


Offset

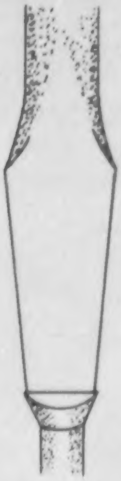

Handle
Ferrule
Blade
Head
Tip

PARTS OF A SCREW DRIVER

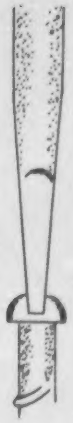
SELECTING THE SCREWDRIVER



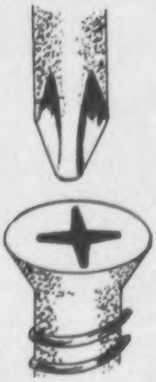
Tip Should
Be Square



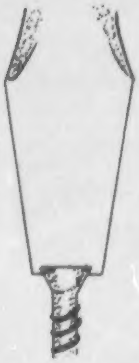
Tip Should Be
Proper Width



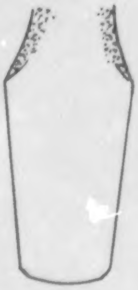
Tip Should Be
Correct Size For Screw



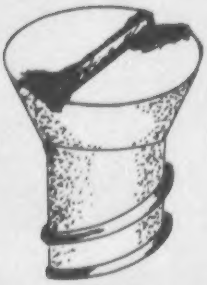
Correct Phillips Tip



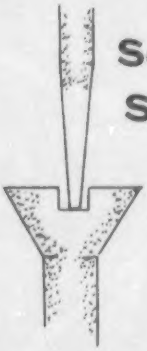
Tip Too Wide



Tip Curved

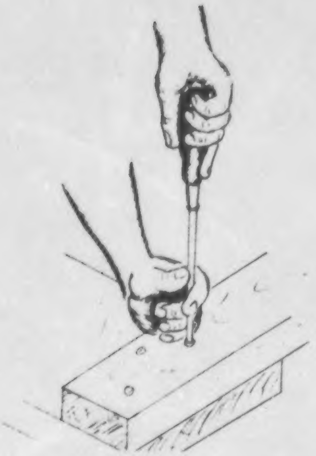


Marred
Screw Head

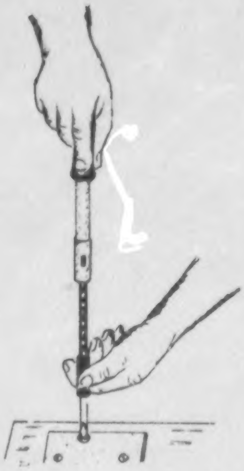


Screw Driver Too
Small For Screw

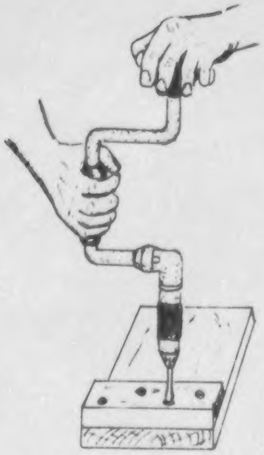
USE OF THE SCREWDRIVER



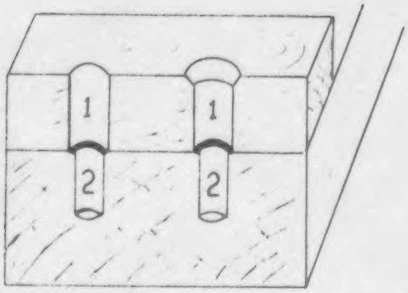
Proper Position of Hands For Standard And Phillips



Proper Position of Hands For Ratchet

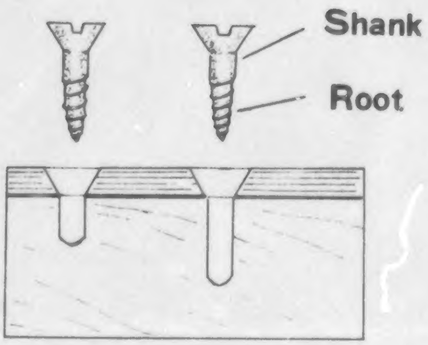


Proper Position of Hands For Use of Screw Driver Bit



Hole No. 1 Is Larger Than Hole No. 2

Fastening Wood



Hole-Soft Wood ½ Thread Distance

Hole-Hardwood Full Length of Screw

Fastening Metal to Wood

AGRICULTURAL MECHANICS

Unit B: Farm Carpentry

Topic 8: Identification and Use of Wood Screws, Nails, Bolts, Staplers, and Other Fasteners

Suggested Procedure and Activities: Exhibits of wood screws, nails, bolts, and other fasteners may be used as a teaching aid during the class discussion.

1. Identification and Use of Wood Screws

a. Using Wood Screws Instead of Nails

Wood screws fasten pieces of wood together more firmly than nails. They also have a greater holding power.

If pieces of wood are taken apart they are less likely to split where screws are used in the place of nails.

Wood screws must be used on certain types of hardware when attaching it to wood. Screws usually match the hardware (hinges and locks).

A wood project put together properly with screws may have a more favorable general appearance than one put together with nails. Screws are usually more decorative than nails.

Transparency No. 1

b. Types of Screws Used on Woodwork

Flathead Screws - These screws are the most popular for attaching or fastening pieces of wood together. They are used where the head is to be covered by a wood plug or dowel.

Round Head Screws - Round head screws are used to give the finished article an ornamental effect and when washers are used, extra holding support is furnished for the object.

Oval Head Screws - These screws are used where it is not necessary to have the screw head flush with the surface. They also give the article an ornamental appearance.

Leg or Coach Screws - The big screws resemble a bolt except at the screw root. They usually have a square head and are used where the regular screw is not strong enough for the work. Leg screws are also used with an expansion shield in brick, concrete, and rock walls.

Drive Screw - The drive screw head is similar to the flat head screw without the slot. The screw actually turns as it is being driven into the wood. It has an auger-type root instead of a threaded root.

Phillips Screw - The only difference between the flat head and Phillips screw is the straight single slot in the flat head screw and the cross-shaped slot in the Phillips screw. The two types of screws can be used for the same purposes. The recessed Phillips screw requires a special screwdriver. It is considered to have a greater drawing power than the regular head screw.

c. Metals and Finish of Wood Screws

Screws are made of steel, brass, alloy, bronze, and copper metals.

Steel screws are used for ordinary work, and they are cheaper than bronze and copper screws.

Brass and alloy-type screws are best suited for construction purposes where the screw is subjected to moisture.

Copper screws are used mainly with copper metals, giving the finished product an ornamental appearance.

Screws are finished in many colors. They are: bright metal, blue, brass, bronze, and copper. Some screws are painted in various colors.

Screws are identified according to length, gauge, finish, and head. For example: a 1-1/4 inch number 10, flathead steel screw is written 1-1/4" - No. 10 F. H. S., and the same screw in brass, but round head, is written 1-1/4"-No. 10 R. H. B. The gauge number of screws range from 0 to 24 and the length from 1/4 to 5 inches.

d. Tools Needed to Drive Screws

Screwdrivers, hand drills and bits, countersink bit, awl, or a tool to start screw hole, and brace and screwdriver bit.

2. Identification and Use of Nails

a. The nail is one of the most commonly used rough hardware.

Nailing was one of the first ways used to join pieces of wood together. The early nail had four flat sides instead of being round. It resembled our present day horseshoe nail.

The term "penny", indicating the common nail size (length), came from one of the following sources of measurement in England.

Six-penny and ten-penny nails could be purchased for either a six-pence or tenpence per 100 nails.

One thousand nails of a certain size (six-penny) weighed six pounds.

The letter "d" is used as a symbol for penny.

Transparency No. 1

b. Types of nails most commonly used are: common, box, finishing, roofing, flooring, plasterboard, casing, and shingle. The two general types of nails are wire cut or cut nails.

Common Nails - These nails are used more frequently than any other type of nail. They are made of wire, have flat heads, and range in size from 2d to 60d. The larger common nails are known as spikes. They are used for rough work where holding power is important. They are used mainly on rough work such as framing, fencing, and form building.

Box Nails - Box nails range in size from 2d to about 40d. They have less tendency to split the lumber than does the common nail due to their being smaller in diameter. The box nail is used for building crates, boxes, and the nailing of siding. They are also made of wire and have flat heads.

Finishing Nails - These nails are used for finish work. The heads are small and barrel shaped so they can be sunk below the surface and the holes filled with a wood filler or putty. The sizes range from 2d to 20d. These nails are used on cabinet trimmings and cupboards.

Roofing Nails - Roofing nails have a very large flat head. The shanks are of different sizes and types. The most common shank is barbed. The nails are used to install rolled or shingle asphalt roofing. They range in size from about 3/4 to 2 inches. These nails are galvanized.

Flooring Nails - As the name indicates, these nails are used mainly for nailing flooring; but they are used on other heavy materials. The nail diameter and head is slightly larger than the finish nail; however, the head can be countersunk. The flooring nail ranges in size from about 7d to 10d.

Plasterboard or Gypsum Board Nails - These nails are small with a flat head. They range in size from 1 to 1-1/4 inches in length. They are used to join plasterboard to a wood base. These nails are also used to apply rock lath (a base for plastering).

Casing Nails - These nails can be used for flooring, but they have a smaller head and smaller shank in diameter than does the flooring nail. The head can be countersunk. These nails range in size from 4d to 40d and are used mainly for outside finish work. They are thicker than a finish nail.

Shingle Nails - Nails of this type are small (3d to 6d) with flat heads. The galvanized box nail is used for wood shingles.

Hinge Nails - There is one other type of nail that is being used for lattice work and roofing because of its holding power; and that is the hinge nail. They have oval or countersunk flat heads and range in size from 4d to 20d.

Other Types of Nails - Other types of nails are: masonry, duplex-headed, ratchet, T, copper clout, lead-capped metal roofing, screw and plain shank roofing, and escutcheon pin.

c. Nail length can be determined in the following manner: A 2d nail is one inch in length and each size thereafter increases 1/4 inch in length through the 16d nail. For example; a 6d nail is 2 inches and 7d is 2-1/4 inches in length. The gauge also becomes larger if the length increases more than two sizes between 4d and 12d nails.

Transparency No. 2

d. Steps to follow when driving a nail are as follows:

After the proper nail has been selected, hold it firmly with the thumb and fingers of one hand, then strike a light blow with the hammer to set the nail for driving.

If more than one nail is used they should be set in a zig-zag line to prevent splitting the wood.

If nails are driven in hardwood, drilling a hole slightly smaller than the nail will prevent the wood from splitting.

Nails driven diagonally will have a better holding effect than nails driven straight into the lumber. Toe-nailing is another way of driving nails at an angle.

The last blow of the hammer should be judged properly in order not to leave a hammer face mark on the board.

Finish, casing, and flooring nails may be set by using a nail set slightly smaller than the head of the nail.

Nails should be clinched across the grain of the wood. Hitting the point of the nail after it has been clinched flat on the surface will make the nailed material safer to handle.

3. Identification and Use of Bolts

a. There are two main purposes for using bolts as fasteners.

Bolts are considered the strongest of all fasteners for wood. They are used where a strain is put on pieces of boards that are jointed together.

Bolts are used in heavy construction where it is necessary to assemble and disassemble objects.

Transparency No. 3

b. Types of bolts most commonly used are: carriage bolts, stove bolts, machine bolts, toggle bolts, and lag bolts with shields.

Carriage bolts are generally considered the woodwork type bolt due to the square shank under the round oval head. The square shank prevents the bolt from turning once it is set in the wood. The head cannot be held by a wrench; therefore, it may be difficult to remove, especially if the bolt is covered with rust. The length may range from about 1 inch to 20 inches. These bolts are threaded like machine bolts.

Stove bolts are used for lighter work than are carriage bolts. They have round and flat slotted heads and may be loosened or tightened with a screwdriver. The stove bolt may be purchased with a Phillips head and in many sizes. The threads extend the full length of the bolt. The length of stove bolts ranges from 3/8 inch to 6 inches.

Machine bolts may be used for heavy wood construction such as livestock feeders, gates, and trusses for buildings. The head of machine bolts can be held with a wrench while it is being tightened. The size range is similar to a carriage bolt, about 1/2 to 1-1/4 inches in diameter, and the length is from 1 to 30 inches. These bolts are used for heavy construction.

Toggle bolts are supplied with a spreading head nut that opens as it passes through the wall; therefore, its main purpose is to fasten objects by drilling a hole and inserting the spreading nut through the hole. It is tightened with a screwdriver. The bolt is designed to join small objects to walls and other objects.

Lag bolts are used with expansion shields to fasten wood and other materials to concrete, bricks, and stone. When a lag screw or bolt is inserted into a metal shield the shield expands in the hole as the square head of the bolt is turned clockwise with a wrench. This bolt does not have a nut. When attaching metal to wood or wood to wood it is necessary to drill two sizes of holes - one for the threaded part and one for the non-threaded part.

Anchor bolts are used to fasten sills and plates to concrete foundations and walls. They can be made in various lengths. Usually only one end of this bolt is threaded.

c. Washers and nuts are necessary when tying wood or metal to concrete, metal, and wood.

Plain washers are usually used with many different types of bolts in woodwork. It is necessary to use washers on both ends of machine bolts and round headed stove bolts if two pieces of wood are joined together. The head end of a carriage bolt may not require a washer due to its having a round flat head. Lock washers are usually used against metal on the nut end of all bolts except the expansion bolt, if it is necessary to permanently set the nut.

Four types of nuts are listed as follows:

The square nut is the most commonly used for agricultural work.

The hexagon nut is seldom used for woodwork.

The castellated nut has an outward slotted lip which holds it in place by a cotter pin. It is seldom used with wood objects.

Thumb nuts or wing nuts are used where frequent adjustment is necessary.

Two ways of removing old rusted bolts and nuts are:

A slot is cut in the top of a carriage bolt with a hacksaw so the bolt can be held with a heavy duty screwdriver while the nut is being loosened. Also, two sides of the head can be cut off, forming a wrench surface for holding the bolt while the nut is removed.

A slot may be cut in the nut end of the bolt and a screwdriver used to keep it from turning while the nut is being removed.

Transparency No. 3

4. Use of Corrugated Fasteners and Staples

Corrugated fasteners are used to join boards together such as corners and butt joints in windows and doors and corners for picture frames.

The thickness of the corrugated fastener should be at least 1/8 inch less than the thickness of the board where it is used.

The fasteners range in size from 1 to about 6 inches in width and from 1/4 to 1 inch in depth. Regardless of the width of the fastener, it should be driven evenly into the material. Hammer blows should be placed so that it enters the board straight and parallel.

Staples range in sizes from 3/8 inch to 2 inches. Wide crown staples have a 1 inch crown. They are used with a staple gun. Staples are used for millwork, asphalt shingles, butt joining, and ceiling materials.

Wire staples are made in different sizes. The staple used to construct barbed wire and heavy net wire fences may be about 1 inch long, while the small mesh wire staple may be less than 3/4 inch in length. Fencing staples vary in length from about 3/4 inch to 2 inches.

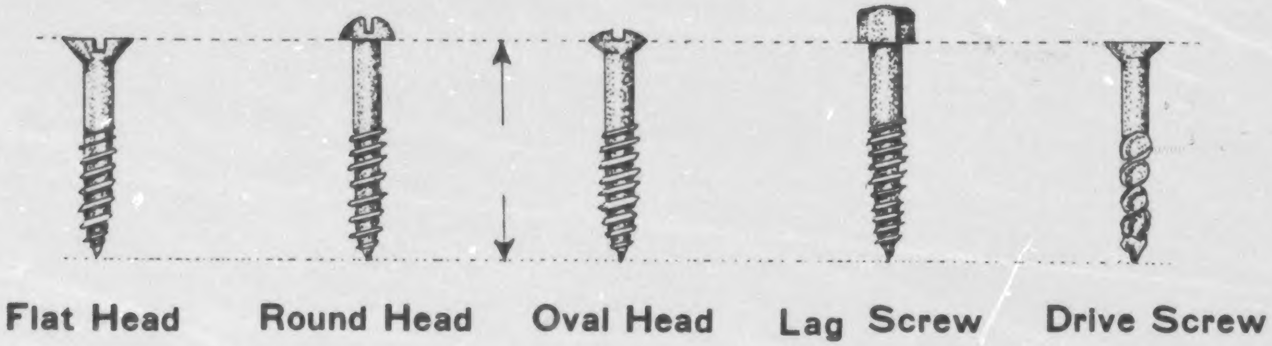
References:

1. Durbahn, Walter E., Fundamentals of Carpentry Tools, Materials, and Practices, Volume I, American Technical Society, Chicago, IL, 1971.

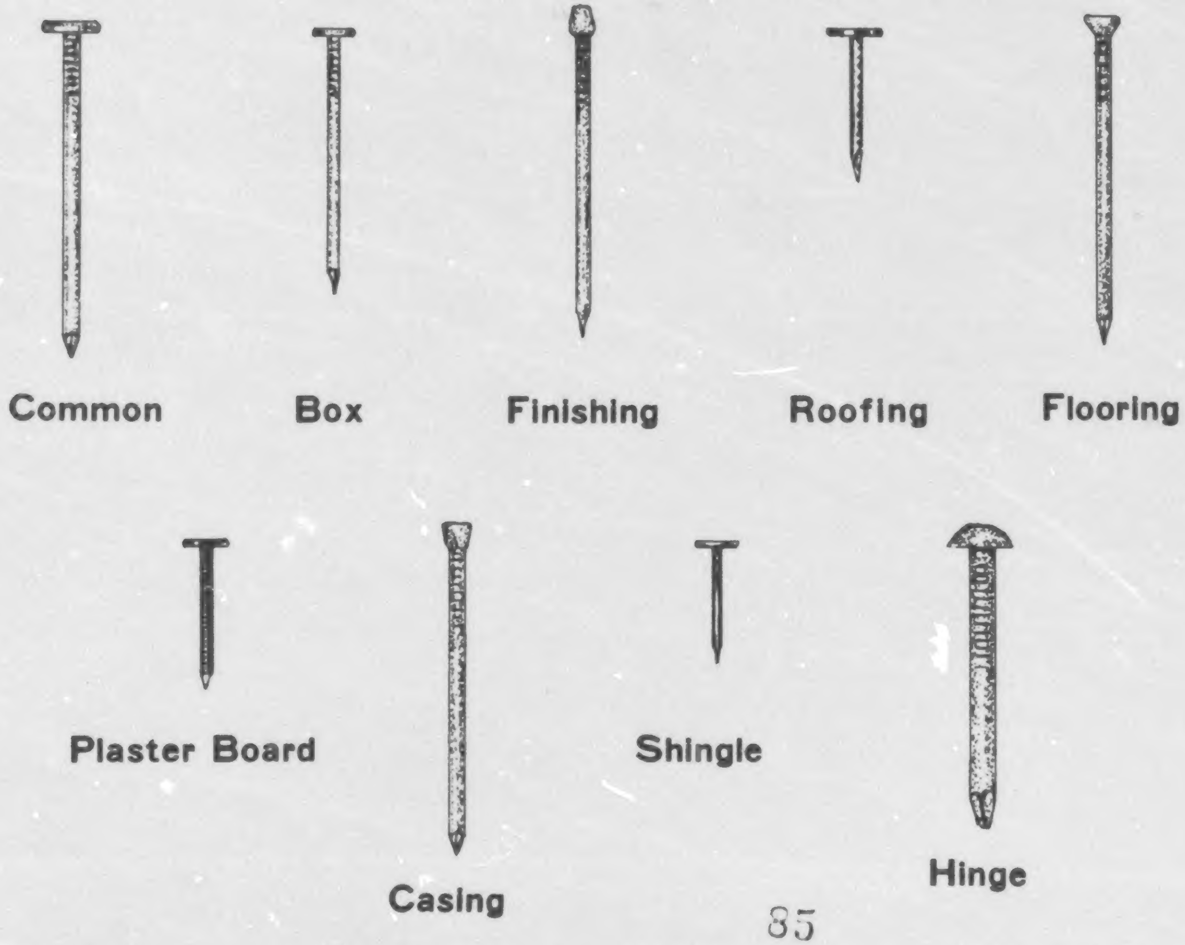
2. Phipps, Lloyd J., Mechanics in Agriculture, The Interstate Printers and Publishers, Inc., Danville, IL, 1967.

3. Wakeman, T. J. and Vernon Lee McCoy, The Farm Shop, The Macmillan Company, New York, NY, 1960.

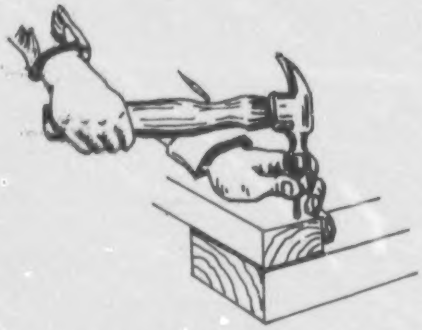
TYPES OF WOOD SCREWS


Flat Head
Round Head
Oval Head
Lag Screw
Drive Screw

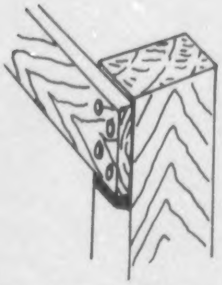
TYPES OF NAILS


Common
Box
Finishing
Roofing
Flooring
Plaster Board
Shingle
Casing
Hinge

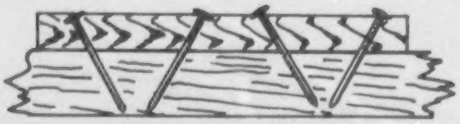
DRIVING NAILS



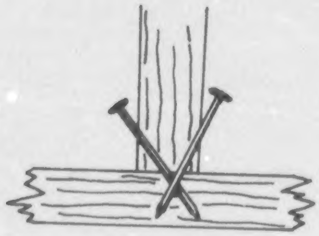
HOLD NAIL WITH
THUMB AND FOREFINGER



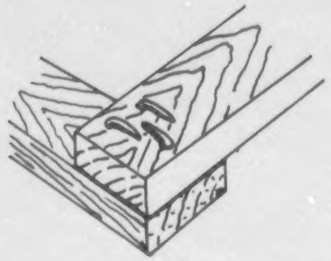
ZIG ZAG NAILS



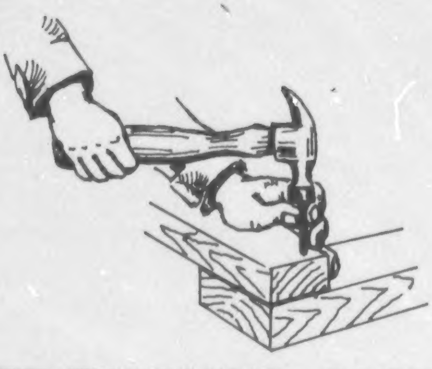
NAILS DRIVEN AT AN ANGLE
GIVE MORE STRENGTH



TOE NAILING

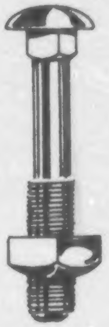


CLINCH NAILS
ACROSS GRAIN

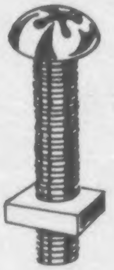


SET FINISHING, CASING
AND FLOORING NAILS
IF NECESSARY

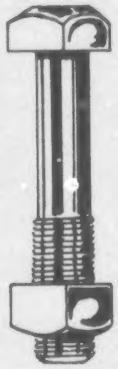
TYPES OF BOLTS AND OTHER FASTENERS



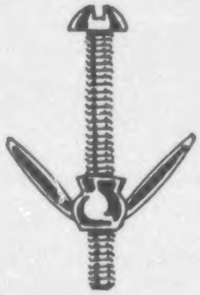
Carriage



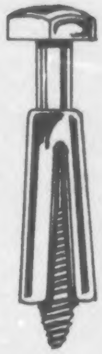
Stove



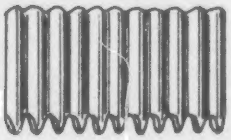
Machine



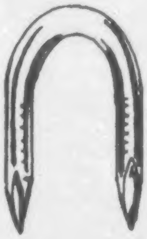
Toggle



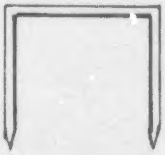
Expansion



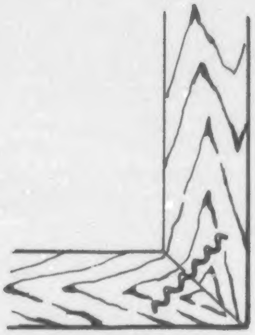
Corrugated fastener



Wire staple



Standard staple



Use of corrugated fastener

Vocational Instructional Services
Agricultural Education

V-B-9
Basic V.A. 1
Agdex .30/30 x 783

AGRICULTURAL MECHANICS

Unit B: Farm Carpentry

Topic 9: Lumber Identification and Computation of Bill of Materials

Suggested Procedure and Activities: Pieces of lumber of all dimensions showing the different grades, miniature structures and building plans with bills of material; and carpenter's steel squares with Essex board measure tables will be helpful during the class discussion.

1. Identification and Selection of Lumber

There are two main classifications of lumber: softwoods and hardwoods. Softwood lumber is cut from pine, cedar, fir, redwood, and cypress. Hardwood lumber is cut from oak, ash, birch, walnut, hickory, and maple. Most farm buildings are constructed of softwood.

There are two general grades of softwoods; select and common. The select grade is divided into four subgrades: A, B, C, and D. The common grade is divided into five subgrades: No. 1, No. 2, No. 3, No. 4, and No. 5. Grades 4 and 5 are usually designated as utility grade.

The two highest grades of hardwoods are called FIRSTS and SECONDS. They are commonly sold together and designated as "FAS". The lower grades of hardwood are the same as for softwoods.

2. Description and Uses of Lumber Grades

The select grades, A, B, C, and D, are for the most part free of knots and blemishes. Select grade lumber is relatively straight grained and is used for fine finish work.

Common grade No. 1 is a general-purpose wood. It may have sound, smooth knots up to about two inches in diameter. Common grade No. 2 is often used for framing or flooring and has slightly larger knots and other blemishes. Common grade No. 3 has loose knots, occasional knotholes, and a limited amount of pitch and season checking. It is used sometimes for framing and shelving. Utility common grades No. 4 and No. 5 are poor quality and are used primarily for temporary structures and crating jobs requiring little strength.

Lumber may be purchased dressed on all four sides (S-4-S), dressed on one side and one edge (S-1-S-1-E), or finished to several other specifications. Rough-sawed lumber is considered to be of normal dimension if it measures full inches in thickness and width. Dressed lumber is a fraction of an inch smaller than rough lumber. For example, a dressed 1"x4" is actually 25/32" x 3 5/8" and a dressed 2x6 is 1 5/8" x 5 5/8". Lumber is usually sold in lengths of 6' 0" to 20' 0".

3. Types and Patterns of Lumber

Transparency No. 1

a. Common Boards: This lumber has square edges with different thicknesses, widths, and lengths.

b. Standard Patterns: (1) Dressed and matched or tongue and groove is known as center-matched. (2) Off-center matched is a tongue and groove cut for flooring. (3) Shiplap is a board with a rabbet cut on each edge. (4) Beveled siding is a board planed at an angle from one edge to the other. (5) Car siding has a V groove in the center and an angle cut on each edge of the grooved side. (6) Drop siding is a tongue and groove board that has a beveled cut on one tongue side. (7) Crib siding is beveled on each edge.

c. Board Lumber: This lumber is one inch or less in thickness.

d. Dimension Lumber: This lumber is normally 1 5/8" thick when dressed. It may be in 4", 6", 8", 10" and 12" widths.

e. Plywood: Plywood is found in 4 feet widths and 8 to 12 feet lengths, with 1/4" to 3/4" thickness by units of 1/8". There is exterior and interior plywood.

f. Hardboard: This board is made of wood fibers. It is 4' in width and 4 to 12 feet in length. The most popular thicknesses are 1/8" and 1/4".

4. Description of Plywood

Plywood is a built-up board made by assembling the veneers with the grain of each layer, or ply, at right angles to the ones adjacent to it. The kiln-dried veneer is united under high pressure with an adhesive producing a bond between layers as strong, or stronger, than the wood itself. An odd number of veneers --- three, five, seven --- is used so the grain direction on the face and back of the panel run in the same direction.

Wood is strong along the grain, but somewhat weaker across the grain. Cross-lamination distributes wood's along-the-grain strength in both directions, creating a panel that is very strong for its weight, split-proof and puncture-proof. Peeling veneers from a log and reassembling them also provides a means for making panels much larger than could be produced by sawing.

5. Types of Plywood

In general, "type" refers to the glue durability and bond that can be expected when plywood is used in various applications.

(a) Exterior-type plywood has a waterproof glue and veneers selected for producing a bond between plies that is stronger than the wood itself. This type is the ultimate in moisture resistance as the glue cannot be weakened by time, weather, or even boiling water.

(b) Interior-type plywood has either highly moisture-resistant or waterproof glue, at the option of the manufacturer. Veneers used in the inner plies and backs, however, are not as high quality as required for Exterior-type. It will withstand occasional wetting during construction, but should not be permanently exposed to the elements.

6. Grades of Plywood

a. Plywood is graded by the appearance quality of the veneer on the face and back of the panel. There are six grades of veneer as follows:

"A" Best standard veneer. Smooth and paintable. May be more than one piece, well jointed. Neatly made repairs permitted.

"B" Solid surface veneer. Circular repair plugs and tight knots permitted. Can be painted.

"C-Plugged" Improved "C" Veneer. Underlayment grade.

"C" Minimum veneer permitted in Exterior-type. Knotholes to 1", splits, plugs, and other repairs permitted. (Occasional knotholes 1/2" larger permitted provided total width of all knots and knotholes within a specified section do not exceed certain limits.)

"D" Used only for inner plies and backs of Interior-type. Knotholes up to 2-1/2" in maximum dimension and an occasional knothole 1/2" larger under certain specified limits.

"N" Special order "natural finish" veneer. Select, all heartwood. Free from open defects. Allows some repairs.

b. These veneer grades are combined to form the following plywood grades:

EXTERIOR-TYPE

Grade	Face	Back	Inner Plies
A-A, Ext.	A	A	C
A-B, Ext.	A	B	C
A-C, Ext.	A	C	C
PlyForm, Class I & II, B-B	B	B	C
B-C, Ext.	B	C	C
C-C, Ext. (plugged)	C*	C	C
C-C, Ext.	C	C	C
Structural I C-C Ext.	C	C	C

INTERIOR-TYPE

Grade	Face	Back	Inner Plies
A-A, Int.	A	A	D
A-B, Int.	A	B	D
A-D, Int.	A	D	D
B-B, Int.	B	B	D
B-D, Int.	B	D	D
Int. Underlayment	C*	D	C & D
C-D (plugged) Int.	C*	D	D
Structural I C-D Int.	C	D	D
Structural II C-D Int.	C	D	D
Standard Int. (Exterior glue)	C	D	D
Standard Int.	C	D	D

* C veneer that has been plugged.

Plywood is purchased by the sheet or square foot.

7. Calculating Board Feet

Transparency No. 2

Lumber prices are figured by the board foot for ordinary lumber. A board foot is the amount of lumber in a piece 1 inch thick, 1 foot wide, and 1 foot long.

Board feet may be calculated by using the board foot formula or the Essex board measure table on the carpenter's steel square.

a. Board Foot Formula: If the lumber length is measured in feet; multiply the number of pieces times the thickness, times the width, times the length, and divide by 12. For example, to find the board feet in 5- 2"x4" - 12' 0" long, proceed as follows:

$$\frac{5x2x4x12=}{12} \text{ 40 board feet}$$

If the length of lumber is given in inches, use the same procedure already used except divide by 144. For example, to find the board feet in 3-1"x6"-40" long, proceed as follows:

$$\frac{3x1x6x40=}{144}\frac{720}{144} = 5 \text{ board feet}$$

Transparency No. 3

b. Essex Board Measure Table: This table appears on the back of the square body and gives the contents in board measure of almost any size of board. The figure "12" on the outer edge represents a board 12 inches wide and one inch thick, and is the starting point for all calculations. The numbers in the column directly under the 12-inch mark indicate the length of lumber in feet. The regular inch divisions of the square represent the widths of boards in inches. The figures under each of these inch marks represent the number of board feet and twelfths of a board foot.

To find the feet of board measure in a piece of lumber, locate under the 12-inch mark the figure corresponding to the length (in feet) of the lumber. Then follow along the horizontal line on which the length is stamped toward the column of figures under the given width of the lumber. The figure appearing at the left-hand side of the vertical line is full feet board measure, and the figure at the right of the vertical line is twelfths of a foot board measure.

The figures in the tables are given for lumber 1 inch thick. To obtain the board measure for any other thickness, mutiply the figure given in the table by the thickness of the lumber.

Example: Calculate the board feet in
1-1"x8" - 10' 0' long.

First find the 10 feet in the column under "12" for the length in feet, then find 8 inches on the top edge of the square for the width in inches. Read the figures in the column on the line corresponding with 10 feet. The number of board feet is 6 8/12 (6-8), reduced to 6 2/3. To find the board feet in 1-2x8 - 10' 0" long, multiply by two (2 x 6 2/3 = 13 1/3 bd. ft.).

8. The Importance and Meaning of a Bill of Materials

A bill of materials gives the number of pieces, dimensions of each piece, kind and amount of materials, and, in some cases, where the material is to be used. A list of materials for a farm pole building may include poles, lumber, concrete or gravel, metal roofing, nails, and hardware. Simply stated, a bill of materials is a list of materials which gives the amount, size, and kind to be used on a specific construction project.

How to Prepare a Bill of Materials

A working sketch usually contains a very simple set of specifications for a given job or project. If a large piece of equipment or a building is constructed or repaired, a set of specifications supplementing the drawing will give a bill of materials necessary for the job. The following procedure may be followed in preparing a bill of materials:

a. Study the sketch or drawing (plan) of the building or piece of equipment.

b. Develop a list of materials that will be used first and then make a detailed list needed for the job.

c. Revise the detailed list by making a bill of materials in standard sizes. List the amount of the material for each stock, size, and give its description or use.

d. Attach the list of materials to the sketch or drawing for future reference.

9. The Unit of Measure for Bill of Materials

a. Board Foot - A board foot is a piece of lumber one foot long, one foot wide, and one inch thick. Most lumber is sold by the board foot or by the 1,000 board feet and grade classification.

b. Running Foot - A running foot is a piece of material one foot long regardless of width and thickness. Molding, narrow finished lumber (1" x2"), most pipe used in plumbing, electrical wire, fencing materials, molding materials, certain kinds of metal roofing, and certain types of reinforcement steel are sold by the running foot. A running foot measure is sometimes referred to as line or measure.

c. Square Foot - A square foot is one foot long and one foot wide regardless of the thickness. Wall and floor tile, plywood and other paneling, concrete slabs, metal roofing, plastic materials, and floor covering (linoleums) are usually sold by the square foot. Some masonry materials are sold on the basis of covering a certain number of square feet.

d. Cubic Foot - A cubic foot is one foot wide, one foot long, and one foot high. Cement and some other masonry materials are sold by the cubic foot.

e. Cubic Yard - A cubic yard is 27 cubic feet. It is one yard (3 feet) on all sides. Sand, gravel, fill dirt, and concrete may be purchased by the cubic yard.

f. Gallon - A gallon is a liquid measure. Paint and painting materials are usually sold by liquid measure. The weight of a gallon of paint is determined by its ingredients. A given quantity of paint is supposed to cover a certain number of square feet.

g. Roll - A roll is something that is rolled into a cylinder or ball. Wire fencing, roofing paper, and certain types of roofing may be purchased by the roll.

h. Square - A square is a term used in roofing. It is 10 feet by 10 feet, or 100 square feet. For example, three bundles of asphalt shingles will cover 100 square feet, and a square of metal roofing will cover 100 square feet.

10. Figuring a Bill of Materials

Transparencies No. 4 and No. 5

Bill of Materials for 12' Feed Trough

Item Name	Material	Description
Legs	1-2"x6"-12'	penta-treated pine
Floor	3-2"x10"-12'	S 4 S No.2 yellow pine
Sides	2-2"x8"-12'	S 4 S No.2 yellow pine
Ends	1-2"x10"-6'	S 4 S No. 2 yellow pine
Braces	1-2"x4"-10'	S 4 S No. 2 yellow pine
	2-2"x4"-12'	S 4 S No. 2 yellow pine
	1-2"x4"-6'	S 4 S No. 2 yellow pine
Nails	3 lbs.	16 d common
Paint	1/4 gallon	Latex Barn Red

Lumber that is sold by the board foot is priced per M (1,000 board feet). For example, if 12 foot 2"x8" lumber is priced at $375.00 per M, 1-2"x8"-12'0" piece of lumber would cost $6.00.

$$\frac{1x2x8-12=}{12} \text{ 16 board feet}$$

$375.00 per thousand board feet or
$.375 per board foot
16 x $.375 = $6.00

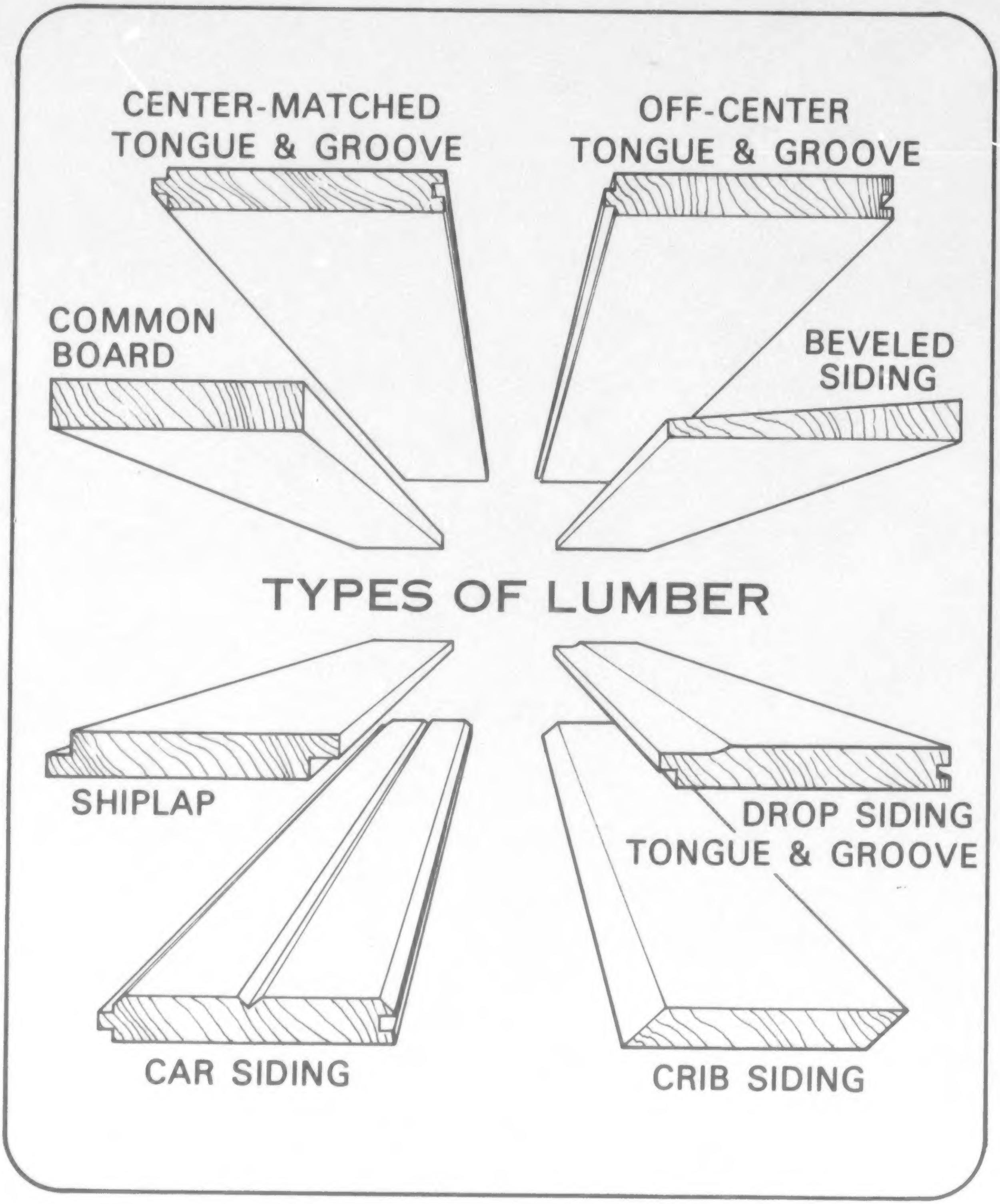
References:

Durbahn, Walter E., Fundamentals of Carpentry, American Technical Society, Chicago, Il 1971.

Phipps, Lloyd J., Mechanics in Agriculture, The Interstate Printers and Publishers, Inc., Danville, Il 1967.

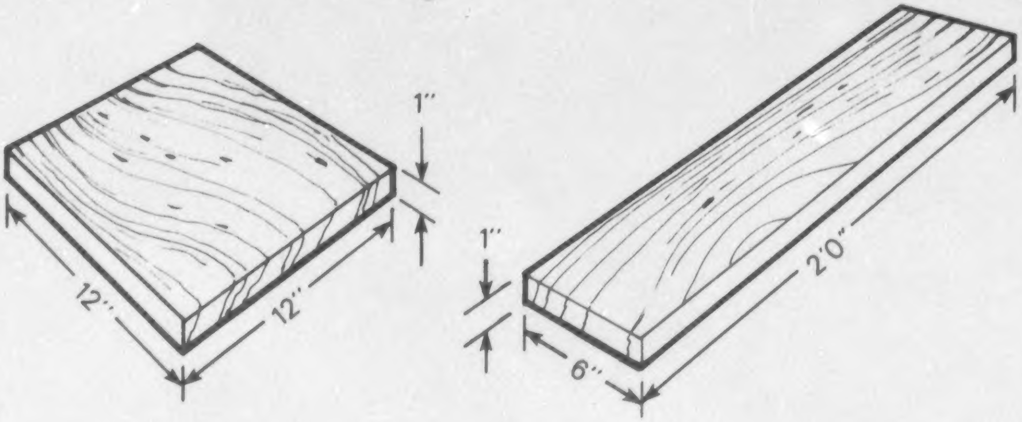
Wakeman, T. J., Modern Agricultural Mechanics, The Interstate Printers and Publishers, Inc., Danville, Il 1977.

"How To Buy and Specify Plywood", Form No. 66-410, American Plywood Association, 1969.


CENTER-MATCHED TONGUE & GROOVE
OFF-CENTER TONGUE & GROOVE
COMMON BOARD
BEVELED SIDING
TYPES OF LUMBER
SHIPLAP
DROP SIDING TONGUE & GROOVE
CAR SIDING
CRIB SIDING

1 Board Foot =

1 - 1"×12" - 1'0" long OR 1 - 1"×6" - 2'0" long



BOARD FOOT FORMULA

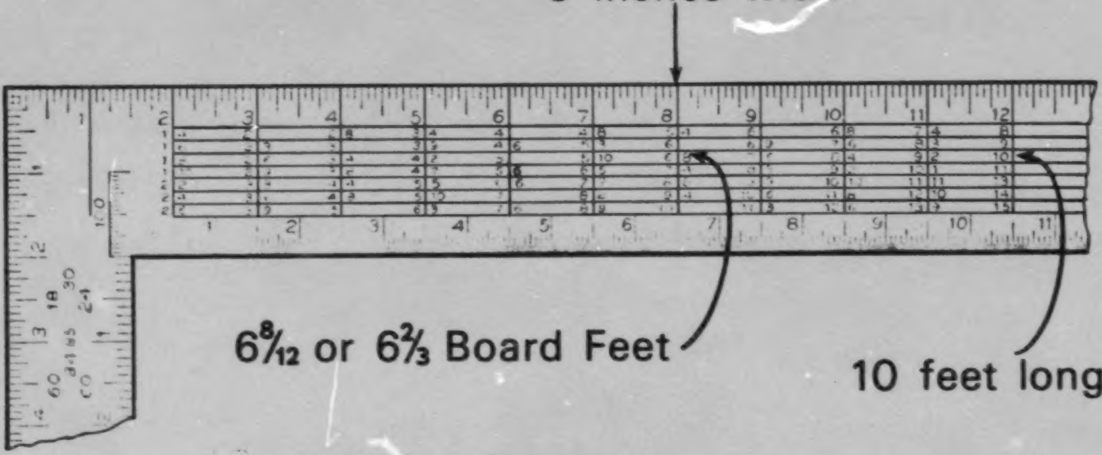
$$\frac{\text{No. of pieces} \times \text{thickness} \times \text{width} \times \text{length}^{\text{(in feet)}}}{12} = \text{Board Feet}$$

EXAMPLE: Board feet in 5-2"×4"-12'0" long

$$\frac{5\times2\times4\times\overset{1}{\cancel{12}}}{\underset{1}{\cancel{12}}} = 40 \text{ Board Feet}$$

$$\text{OR} \quad \frac{5\times2\times4\times12}{12} = \frac{360}{12} = 40 \text{ Board Feet}$$

ESSEX BOARD MEASURE TABLE



8 inches wide

$6\frac{8}{12}$ or $6\frac{2}{3}$ Board Feet

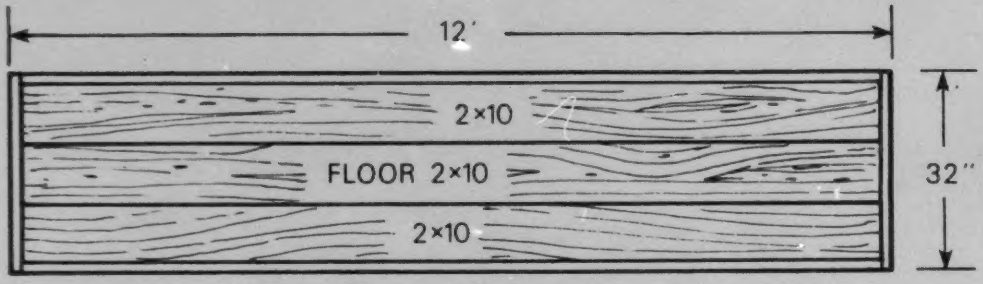
10 feet long

Example: Board Measure of 1-1″×8″-10′0″ long

- Find 10′0″ length under "12" column
- Move horizontally to "8" column representing width
- Move vertically down to find board feet

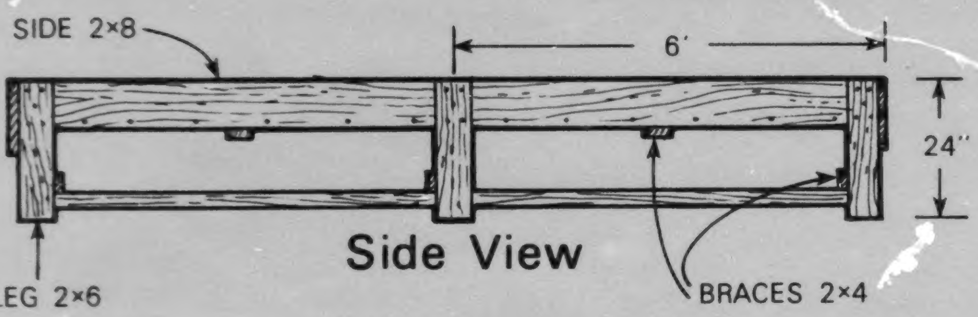
1-1″×8″-10′0″ = $6\frac{2}{3}$ Board Feet

WORKING SKETCH-12 FOOT FEED TROUGH



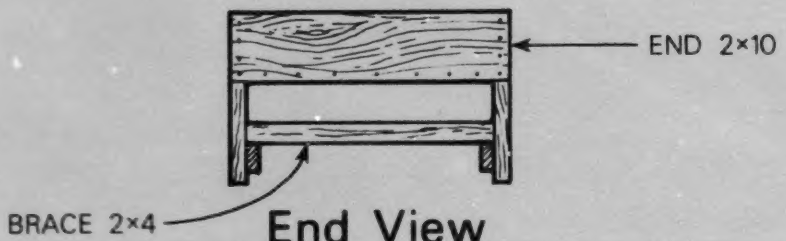
12'
2×10
FLOOR 2×10
2×10
32"

Top View



SIDE 2×8
6'
24"
LEG 2×6
BRACES 2×4

Side View



END 2×10
BRACE 2×4

End View

BILL OF MATERIALS - 12 FOOT FEED TROUGH

Item	Material and Description	Amount	Cost per M	Cost
Legs	1 - 2" x 6" - 12' penta	12 bd. ft.	$450.00	$ 5.40
Floor	3 - 2" x 10" - 12' S4S No. 2	60 bd. ft.	375.00	22.50
Sides	2 - 2" x 8" - 12' S4S No. 2	32 bd. ft.	375.00	12.00
Ends	1 - 2" x 10" - 6' S4S No. 2	10 bd. ft.	375.00	3.75
Braces	1 - 2" x 4" - 6' S4S No. 2	4 bd. ft.	320.00	1.28
	1 - 2" x 4" - 10' S4S No. 2	7 bd. ft.	320.00	2.24
	2 - 2" x 4" - 12' S4S No. 2	16 bd. ft.	320.00	5.12
Nails	16d common	3 lbs.	.50 per lb.	1.50
Paint	Latex Barn Red	1/4 gallon	10.00 per gal.	2.50
			TOTAL	$56.29

EXAMPLE COST CALCULATION

$$\text{(Legs)} \quad \frac{1 \times 2 \times 6 \times \overset{1}{\cancel{12}}}{\underset{1}{\cancel{12}}} = 12 \text{ bd. ft.}$$

12 bd. ft. × 45¢ per bd. ft. = $5.40
($450.00 per M)

8113

STUDENT MATERIALS

V. A. I
V-B-9

LUMBER IDENTIFICATION AND COMPUTATION OF BILL OF MATERIALS

I. Lumber Identification

Lumber may be classified as softwood or hardwood. Softwood lumber is cut from coniferous evergreen trees such as pine, cedar, fir, redwood, or cypress. Hardwood lumber is cut from deciduous trees such as oak, ash, birch, walnut, hickory, or maple. Most farm buildings are constructed of softwood.

There are two general grades of softwoods; select and common. The select grade is divided into four subgrades: A, B, C, and D. The common grade is divided into five subgrades: No. 1, No. 2, No. 3, No. 4, and No. 5. Grades 4 and 5 are usually designated as utility grade.

The two highest grades of hardwoods are called FIRSTS AND SECONDS. They are commonly sold together and designated as "FAS". The lower grades of hardwood are the same as for softwoods.

1. Description of Lumber Grades

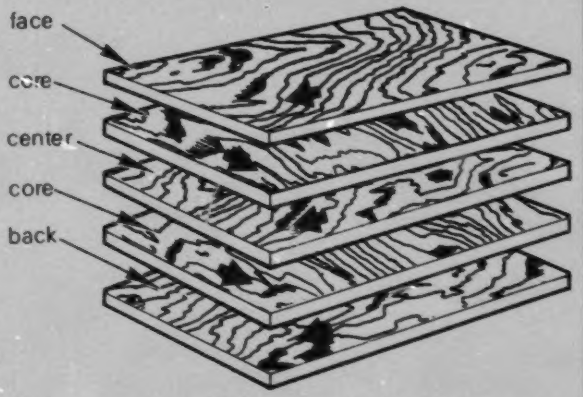
The select grades, A, B, C, and D, are for the most part free of knots and blemishes. Select grade lumber is relatively straight grained and is used for fine finish work. Availability of select grades is scarce. Most commonly available is C-grade.

Common grade No. 1 is a general-purpose wood. It may have sound, smooth knots up to about two inches in diameter. Common grade No. 2 is often used for framing or flooring and has slightly larger knots and other blemishes. Common grade No. 3 has loose knots, occasional knotholes, and a limited amount of pitch and season checking. It is used sometimes for framing and shelving. Utility common grades No. 4 and 5 are poor quality and are used primarily for temporary structures and crating jobs requiring little strength.

Lumber may be purchased dressed on all four sides (S-4-S), dressed on one side and one edge (S-1-S-1-E), or finished to several other specifications. Roughsawed lumber is considered to be of normal dimension if it measures full inches in thickness and width. Dressed lumber is a fraction of an inch smaller than rough lumber. For example, a dressed 1"x4" is actually 25/32" x 3 5/8" and a dressed 2x6 is 1 5/8" x 5 5/8". Lumber is usually sold in lengths of 6'0" to 20' 0".

2. Description of Plywood

Plywood is a built-up board made by assembling the veneers with the grain of each layer, or ply, at right angles to the ones adjacent to it. The kiln-dried veneer is united under high pressure with an adhesive producing a bond between layers as strong, or stronger, than the wood itself. An odd number of veneers --- three, five, seven --- is used so the grain direction on the face and back of the panel run in the same direction.



composition and grain direction of a sheet of plywood

Wood is strong along the grain, but somewhat weaker across the grain. Cross-lamination distributes wood's along-the-grain strength in both directions, creating a panel that is very strong for its weight, split-proof, and puncture-proof. Peeling veneers from a log and reassembling them also provides a means for making panels much larger than could be produced by sawing.

3. Types of Plywood

In general, "type" refers to the glue durability and bond that can be expected when plywood is used in various applications.

a. Exterior-type plywood has a water proof glue and veneers selected for producing a bond between plies that is stronger than the wood itself. This type is the ultimate in moisture resistance as the glue cannot be weakened by time, weather, or even boiling water.

b. Interior-type plywood has either highly moisture-resistant or waterproof glue, at the option of the manufacturer. Veneers used in the inner plies and backs, however, are not as high quality as required for Exterior-type. It will withstand occasional wetting during construction, but should not be permanently exposed to the elements. Basically, the difference between exterior and interior plywood is the quality of the inner plies (interior has "D" grade and exterior has "C" grade) and the glue durability.

4. Grades of Plywood

a. Plywood is graded by the appearance quality of the veneer on the face and back of the panel. There are six grades of veneer as follows:

"A" Best standard veneer. Smooth and paintable. May be more than one piece, well jointed. Neatly made repairs permitted.

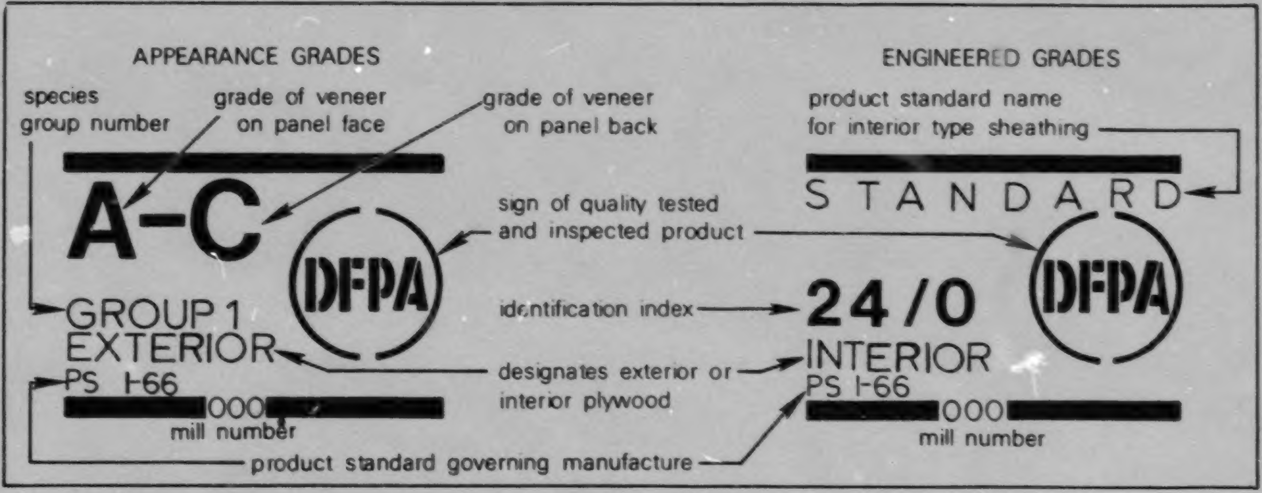
"B" Solid surface veneer. Circular repair plugs and tight knots permitted. Can be painted.

"C"-Plugged"	Improved "C" Veneer.	Underlayment grade.

"C" Minimum veneer permitted in Exterior-type. Knotholes to 1" splits, plugs, and other repairs permitted. (Occasional knotholes 1/2" larger permitted provided total width of all knots and knotholes within a specified section do not exceed certain limits.)

"D" Used only for inner plies and backs of Interior-type. Knotholes up to 2-1/2" in maximum dimension and an occasional knothole 1/2" larger under certain specified limits.

"N" Special order "natural finish" veneer. Select, all heartwood. Free from open defects. Allows some repairs.


APPEARANCE GRADES
ENGINEERED GRADES
species group number
grade of veneer on panel face
grade of veneer on panel back
product standard name for interior type sheathing
A-C
STANDARD
sign of quality tested and inspected product
DFPA
identification index
24/0
GROUP 1
EXTERIOR
INTERIOR
designates exterior or interior plywood
PS 1-66
000
mill number
product standard governing manufacture

b. These veneer grades are combined to form the following plywood grades:

EXTERIOR-TYPE

Grade	Face	Back	Inner Plies
A-A, Ext.	A	A	C
A-B, Ext.	A	B	C
A-C, Ext.	A	C	C
Plyform, Class I & II, B-B	B	B	C
B-C, Ext.	B	C	C
C-C, Ext. (plugged)	C*	C	C
C-C, Ext.	C	C	C
Structural I C-C Ext.	C	C	C

INTERIOR-TYPE

Grade	Face	Back	Inner Plies
A-A, Int.	A	A	D
A-B, Int.	A	B	D
A-D, Int.	A	D	D
B-B, Int.	B	B	D
B-D, Int.	B	D	D
Int. Underlayment	C*	D	C& D
C-D (plugged) Int.	C*	D	D
Structural I C-D Int.	C	D	D
Structural II C-D Int.	C	D	D
Standard Int. (Exterior glue)	C	D	D
Standard Int.	C	D	D

*C veneer that has been plugged. Plywood is purchased by the sheet or square foot.

5. Types and Patterns of Lumber

a. Common Boards: This lumber has square edges with different thicknesses, widths, and lengths.

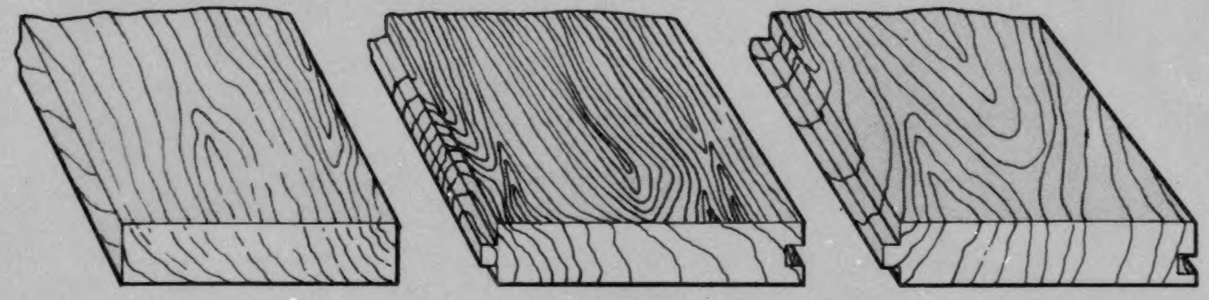
b. Board Lumber: This lumber is one inch or less in thickness.

c. Dimension Lumber: This lumber is normally 1 5/8" thick when dressed. It may be in 4", 6", 8", 10", and 12" widths.

d. Plywood: Plywood is found in 4 feet widths and 8 to 12 feet lengths, with 1/4" to 3/4" thickness by units of 1/8". There is exterior and interior plywood.

e. Hardboard: This board is made of wood fibers. It is 4' in width and 4 to 12 feet in length. The most popular thicknesses are 1/8" and 1/4".

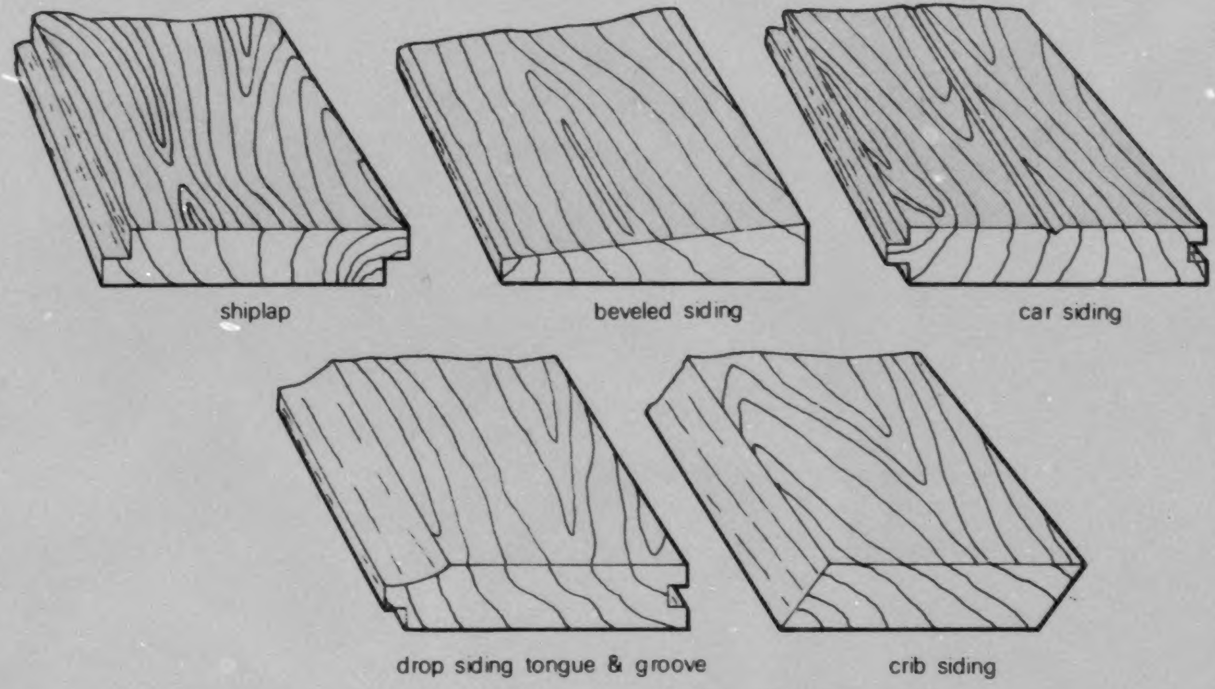
f. Standard Patterns: (1) Dressed and matched or tongue and groove is known as center-matched. (2) Off-center matched is a tongue and groove cut for flooring. (3) Shiplap is a board with a rabbet cut on each edge. (4) Beveled siding is a board planed at an angle from one edge to the other. (5) Car siding has a V groove in the center and an angle cut on each edge of the groove side. (6) Drop siding is a tongue and groove board that has a beveled cut on one tongue side. (7) Crib siding is beveled on each edge.



common board

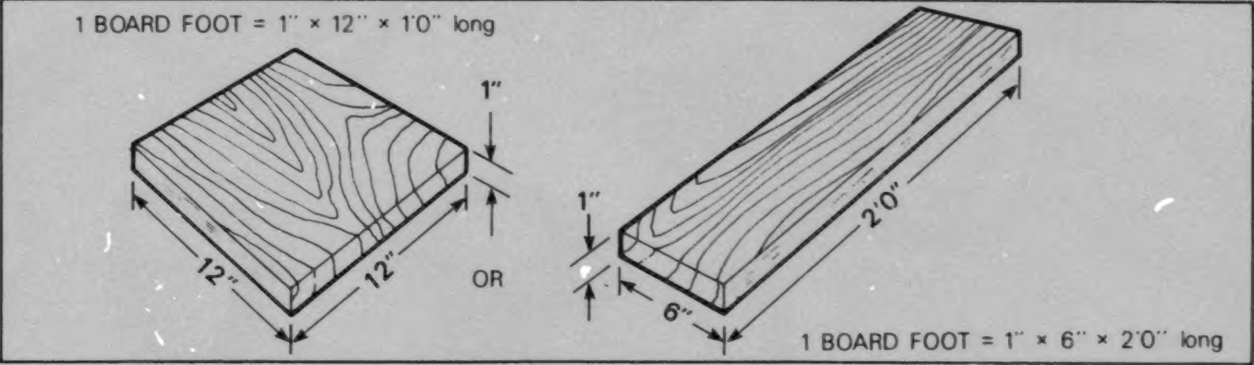
center-matched tongue & groove

off-center tongue & groove


shiplap
beveled siding
car siding
drop siding tongue & groove
crib siding

6. Calculating Board Feet

Lumber prices are figured by the board foot for ordinary lumber. A board foot is the amount of lumber in a piece 1 inch thick, 1 foot wide, and 1 foot long.


1 BOARD FOOT = 1" × 12" × 1'0" long
1"
12"
12"
OR
1"
2'0"
6"
1 BOARD FOOT = 1" × 6" × 2'0" long

Board feet may be calculated by using the board foot formula or the Essex board measure table on the carpenter's steel square.

a. Board Foot Formula: If the lumber length is measured in feet; multiply the number of pieces times the thickness, times the width, times the length, and divide by 12. For example, to find the board feet in 5-2"x4" - 12'0" long, proceed as follows:

$$\frac{5 \times 2 \times 4 \times 12}{12} = 40 \text{ board feet}$$

If the length of lumber is given in inches, use the same procedure already used except divide by 144. For example, to find the board feet in 3-1"x6" 40" long, proceed as follows:

$$\frac{3 \times 1 \times 6 \times 40}{144} = \frac{720}{144} = 5 \text{ board feet}$$

b. **Essex Board Measure Table:** This table appears on the back of the square body and gives the contents in board measure of almost any size of board. The figure "12" on the outer edge represents a board 12 inches wide and one inch thick, and is the starting point for all calculations. The numbers in the column directly under the 12-inch mark indicate the length of lumber in feet. The regular inch divisions of the square represent the widths of boards in inches. The figures under each of these inch marks represent the number of board feet and twelfths of a board foot.

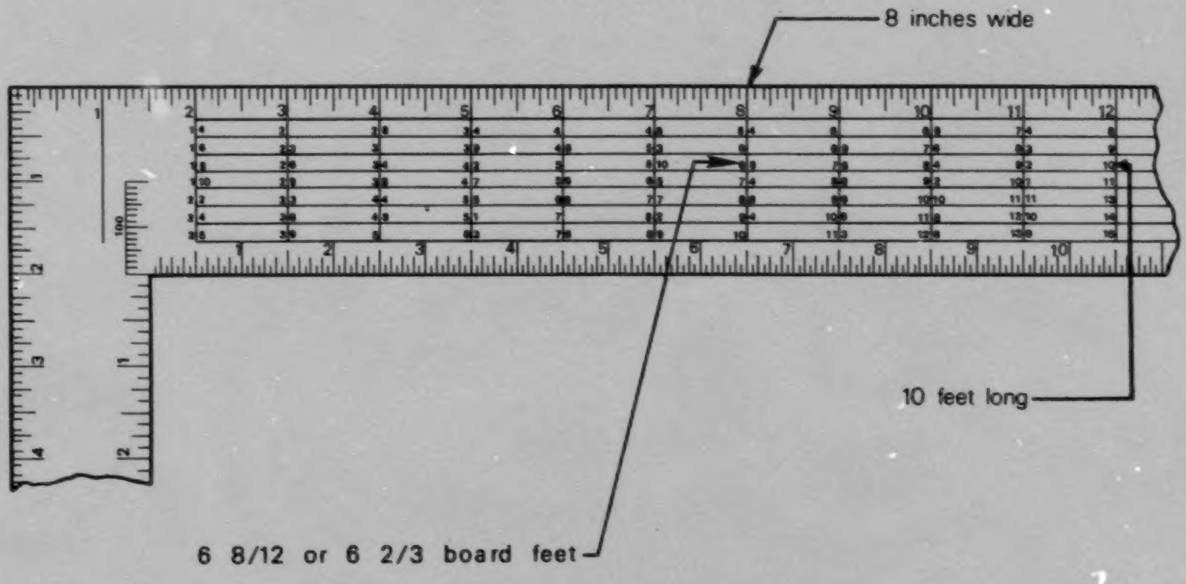
To find the feet of board measure in a piece of lumber, locate under the 12-inch mark the figure corresponding to the length (in feet) of the lumber. Then follow along the horizontal line on which the length is stamped toward the column of figures under the given width of the lumber. The figure appearing at the left-hand side of the vertical line is full feet board measure, and the figure at the right of the vertical line is twelfths of a foot board measure.

The figures in the table are given for lumber 1 inch thick. To obtain the board measure for any other thickness, mutiply the figure given in the table by the thickness of the lumber.

Example: Calculate the board feet in
1-1"x8" - 10' 0' long.

First find the 10 feet in the column under "12" for the length in feet, then find 8 inches on the top edge of the square for the width in inches. Read the figures in the column on the line corresponding with 10 feet. The number of board feet in 6 8/12 (6-8), reduced to 6 2/3. To find the board feet in 1-2x8 - 10' 0" long, multiply by two (2x 6 2/3 =13 1/3 bd. ft.).

ESSEX BOARD MEASURE TABLE



II. Computation of Bill of Materials

A bill of materials gives the number of pieces, dimensions of each piece, kind and amount of materials, and, in some cases, where the material is to be used. A list of materials for a farm pole building may include poles, lumber, concrete or gravel, metal roofing, nails, and hardware. Simply stated, a bill of materials is a list of materials which gives the amount, size, and kind to be used on a specific construction project.

1. How to Prepare a Bill of Materials

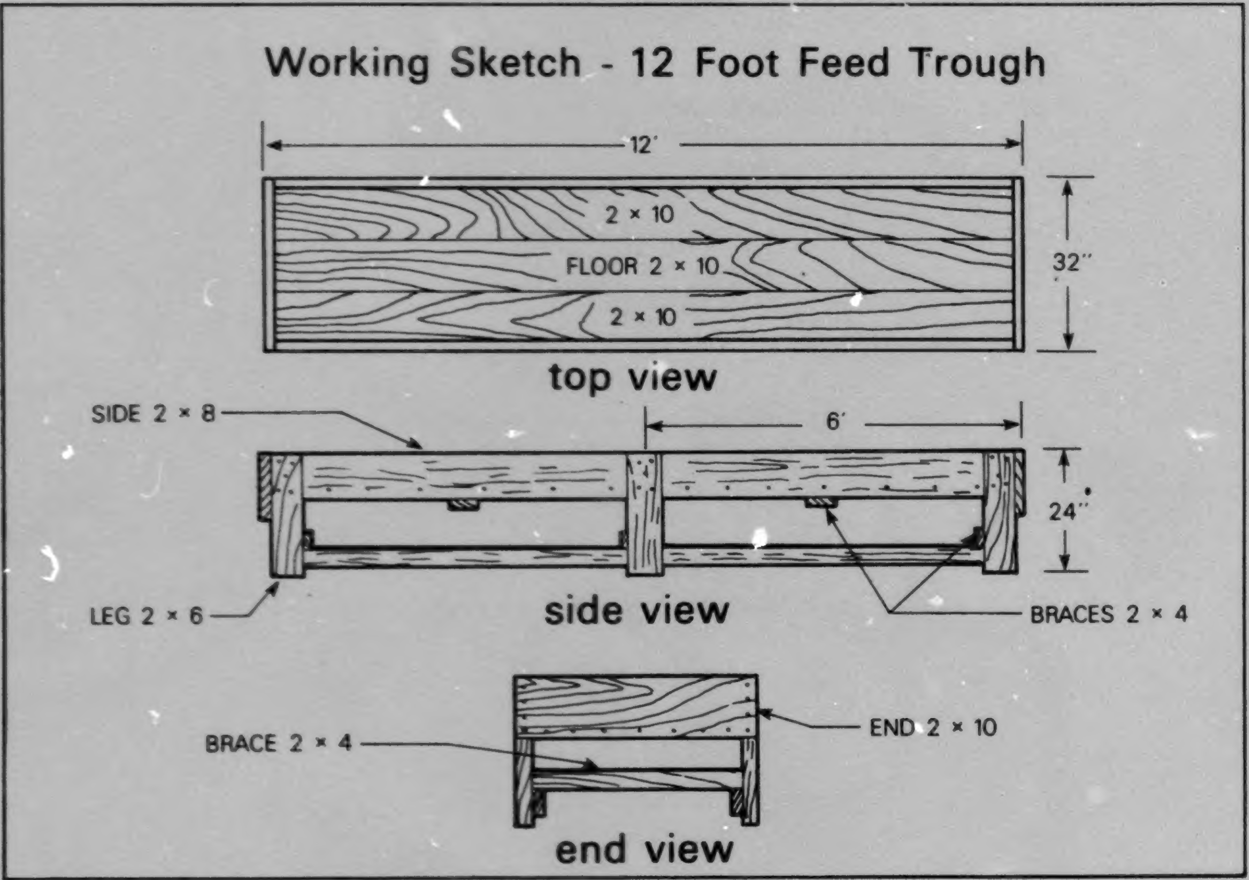
A working sketch usually contains a very simple set of specifications for a given job or project. If a larger piece of equipment or a building is constructed or repaired, a set of specifications supplementing the drawing will give a bill of materials necessary for the job. The following procedure may be followed in preparing a bill of materials:

a. Study the sketch or drawing (plan) of the building or piece of equipment.

b. Develop a list of materials that will be used first and then make a detailed list needed for the job.

c. Revise the detailed list by making a bill of materials in standard sizes. List the amount of the material for each stock, size, and give its description or use.

d. Attach the list of materials to the sketch or drawing for future reference.



Working Sketch - 12 Foot Feed Trough

2. Figuring a Bill of Materials

Lumber that is sold by the board foot is priced per M (1,000 board feet). For example, if 12 foot 2"x8" lumber is priced at $375.00 per M, 1-2"x8" - 12'0" piece of lumber would cost $6.00.

$$\frac{1x2x8\text{-}12}{12} = 16 \text{ board feet}$$

$375.00 per thousand board feet or
$.375 per board foot
16 x $.375=$6.00

Bill of Materials - 12 Foot Feed Trough

Item	Material and Description	Amount	Cost per M	Cost
Legs	1 - 2" x 6" - 12 penta	12 bd. ft.	$450.00	$ 5.40
Floor	3 - 2" x 10" - 12' S4S No. 2	60 bd. ft.	375.00	22.50
Sides	2 - 2" x 8" - 12' S4S No. 2	32 bd. ft.	375.00	12.00
Ends	1 - 2" x 10" - 6' S4S No. 2	10 bd. ft.	375.00	3.75
	1 - 2" x 4" - 6'	4 bd. ft.	320.00	1.28
Braces	1 - 2" x 4" - 10' S4S No.2	7 bd. ft.	320.00	2.24
	2 - 2" x 4" - 12'	16 bd. ft.	320.00	5.12
Nails	16d common	3 lbs.	.50 per lb.	1.50
Paint	Latex Barn Red	1/4 gallon	10.00 per gal.	2.50
			TOTAL	$56.29

3. Units of Measure for Bill of Materials

   a. Board Foot - A board foot is a piece of lumber one foot long, one foot wide, and one inch thick. Most lumber is sold by the board foot or by the 1,000 board feet and grade classification

   b. Running Foot - A running foot is a piece of material one foot long regardless of width and thickness. Molding, narrow finished lumber (1" x 2"), most pipe used in plumbing, electrical wire, fencing materials, molding materials, certain kinds of metal roofing, and certain types of reinforcement steel are sold by the running foot. A running foot measure is sometimes referred to as line or measure.

   c. Square Foot - A square foot is one foot long and one foot wide regardless of the thickness. Wall and floor tile, plywood and other paneling, concrete slabs, metal roofing, plastic materials, and floor covering (linoleums) are usually sold by the square foot. Some masonry materials are sold on the basis of covering a certain number of square feet.

   d. Cubic Foot - A cubic foot is one foot wide, one foot long, and one foot high. Cement and some other masonry materials are sold by the cubic foot.

   e. Cubic Yard - A cubic yard is 27 cubic feet. It is one yard (3 feet) on all sides. Sand, gravel, fill dirt, and concrete may be purchased by the cubic yard.

   f. Gallon - A gallon is a liquid measure. Paint and painting materials are usually sold by liquid measure. The weight of a gallon of paint is determined by its ingredients. A given quantity of paint is supposed to cover a certain number of square feet.

   g. Roll - A roll is something that is rolled into a cylinder or ball. Wire fencing, roofing paper, and certain types of roofing may be purchased by the roll.

   h. Square - A square is a term used in roofing. It is 10 feet by 10 feet, or 100 square feet. For example, three bundles of asphalt shingles will cover 100 square feet, and a square of metal roofing will cover 100 square feet.

SUGGESTED STUDENT ACTIVITIES

I. True or False (place T or F in the blank)

_____ 1. Hardwood lumber is cut from coniferous evergreen trees.

_____ 2. Most farm buildings are constructed of hardwood.

_____ 3. Common grade No. 2 lumber is generally used for framing and may have sound knots over two inches in diameter and other blemishes.

_____ 4. S-4-S refers to lumber dressed on all four sides.

_____ 5. Plywood always has an odd number of veneers or plies.

_____ 6. The basic difference between interior and exterior plywood is the quality of the inner plies and the glue durability.

_____ 7. A 2x4 is an example of dimension lumber.

_____ 8. Board feet can be calculated by formula or by using the Essex Board Measure Table.

_____ 9. The Essex Board Measure Table is on both sides of the carpenter's steel square.

_____ 10. Cost per "M" refers to cost of lumber per 100 board feet.

II. Fill in the blank to complete each statement.

1. Dressed lumber is a fraction of an inch ____________________ than rough lumber.

2. ____________________ is a built-up board made by assembling the veneers with the grain of each ply at right angles to the ones adjacent to it.

3. A-C exterior plywood has ____________________ grade of veneer on the panel back.

4. ____________________ lumber is one inch or less in thickness.

5. A __________________ ____________________ is the amount of lumber in a piece 1 inch thick, 1 foot wide, and 1 foot long.

6. A ____________________ ___ ______________ is a list of materials which gives the amount, size, and kind to be used on a specific construction project.

7. A ________________ ______________ is a piece of material one foot long regardless of width and thickness.

8. A ______________________ is a term used in roofing and measures 100 square feet.

9. No. 4 and No. 5 utility common grades of lumber are _________ __________ and should be used for temporary structures and crating requiring little strength.

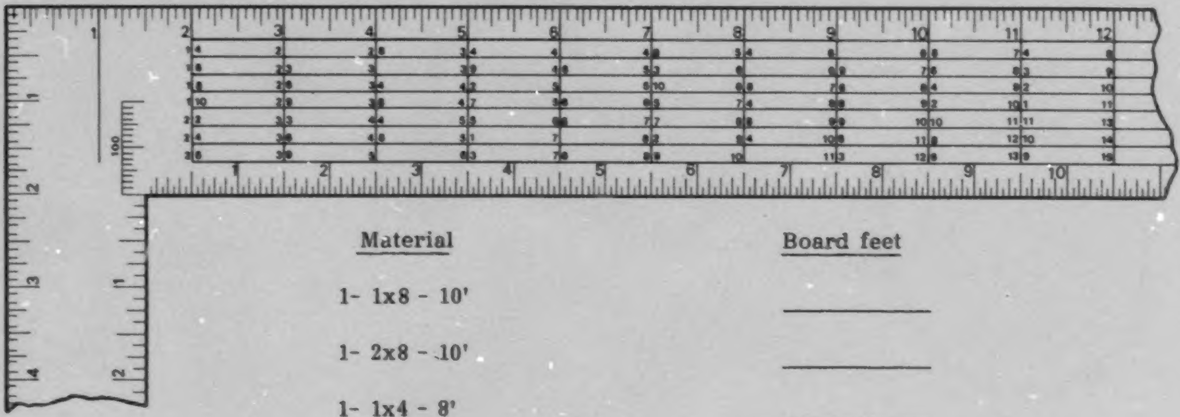
10. Lumber ______________ are figured by the board foot for ordinary lumber.

III. Problem Solving:

1. Using the board foot formula, calculate the board feet in the following list of materials.

Material	Board feet
7- 2x4 - 12'	______
6- 1x10 - 10'	______
1- 1x4 - 16'	______
5- 2x8 - 14'	______
Total	______

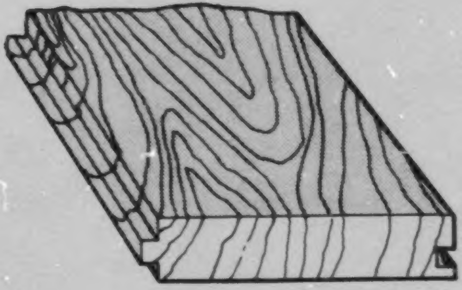
2. Using the Essex Board Measure Table. calculate the board feet in the following list of materials.



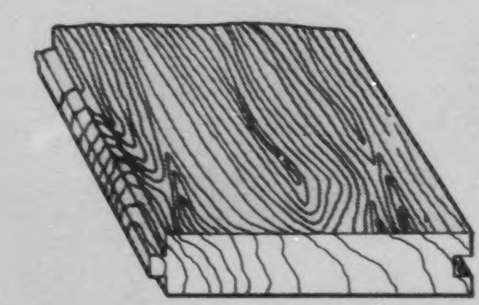
Material	Board feet
1- 1x8 - 10'	______
1- 2x8 - 10'	______
1- 1x4 - 8'	______
6- 1x6 - 14'	______
Total	______

3. Prepare a working sketch and bill of materials for a shop or home project.

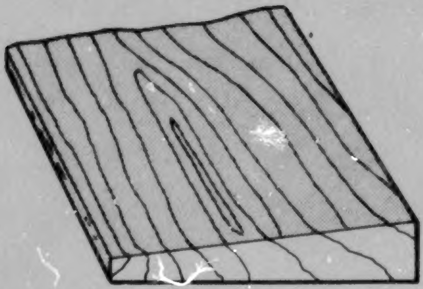
IV. Identify the following patterns of lumber:



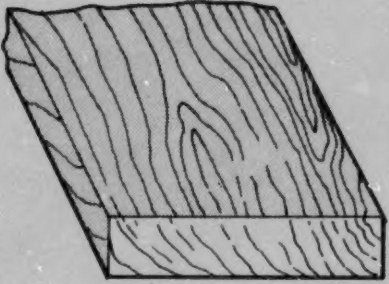
1. ______



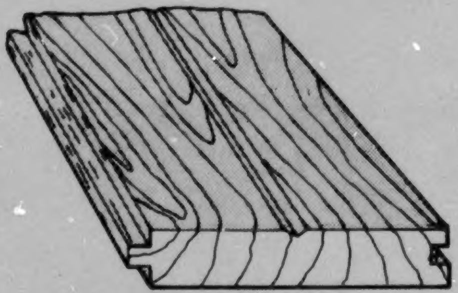
2. ______



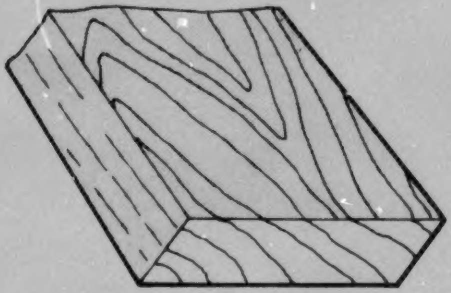
3. ______________________



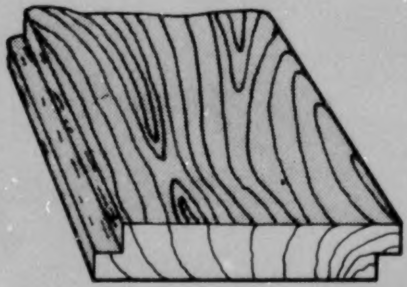
4. ______________________



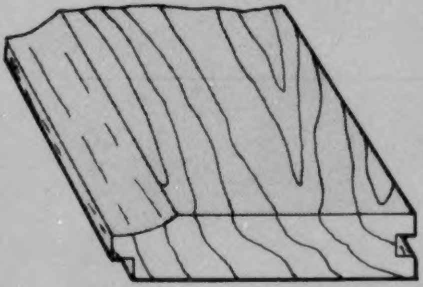
5. ______________________



6. ______________________



7. ______________________



8. ______________________

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AGRICULTURAL MECHANICS

Unit B: Farm Carpentry

Topic 10: Measuring and Marking Devices

Suggested Procedures and Activities: Measuring and marking tools displayed in the classroom may add interest to the class discussion.

1. Importance of Measuring and Marking Devices

Measuring and marking tools are some of the most important tools found in any agricultural mechanics program. Without proper measuring and marking devices, projects would lose much of their quality through the lack of good workmanship. Rules, tapes, squares, and other marking devices are just as important as any other woodworking hand tool, if properly used.

Standard linear measurements in woodworking are the foot, inch, and fraction of an inch. Measuring tools are usually divided into marking on one foot, one inch, one-half inch, one-fourth inch, one-eighth inch, and one-sixteenth inch. Carpenter's steel squares may be graduated by one-tenth and one-twelfth of an inch.

Area or space of a construction project is determined by the use of a measuring device. Materials are purchased according to units of measure from a measuring device, and in many cases, construction materials are sold by using a device to determine the size of the material needed. Lumber yards and hardware stores usually have measuring tools on hand for their local use in making sales.

Transparencies Nos. 1 and 2

2. The Description and Use of the Common Types of Squares

a. Framing or Carpenter's Square

This square is L-shaped with a 24 inch long and 2 inch wide body and a 16 inch long and 1-1/2 inch wide tongue. The blade and tongue arrangement forms a right angle. On most squares the inch is divided in several graduations.

The framing square may have the following tables on the tongue and blade: brace table, for laying out common braces; the rafter table, which gives the lengths of different types of rafters; the octagon table, for making eight-sided objects; and the Essex table, for determining the board feet.

Some Uses of the Framing Square are:

Boards are squared for cutting by placing the blade firmly against the edge of the board and marking against the tongue.

Another use is to lay out angles by observing a certain distance of the blade and the tongue as used for rafter cutting or making polygons and cutting at 45 degree angles. For example, using the same number on the blade and tongue (6 inch blade and 6 inch tongue), certain points on the edge of the board will give a 45 degree cut or angle. It also can be used for measuring length.

b. Try and Miter Square

The handle and blade form two angles, 90 and 45 degrees, the same angles as found on the combination square. The blade ranges from 6 to 12 inches in length.

c. Try Square

The try square most commonly used is a six inch blade. The handle is not used for measuring. The blade is graduated into one inch, one-half inch, one-fourth inch, and one-eighth inch. Actually the blade length may vary from 6 to 12 inches.

It is used mainly to test the squareness or accuracy of cut. This square may also be used for short measurements and laying out lines across the face of a board from the edge. The try square is similar to the framing square in that the hand and blade form a 90 degree angle.

d. Combination Square

The combination square consists of a face and head. The head is equipped with a spirit level. The blade is of several different lengths, but the 12 inch blade is most commonly used. The common head has a 90 and 45 degree angle to the blade. It is attached to the blade by a slot in the blade's center. The head can be moved up or down on the blade. It is graduated from one inch to one-sixteenth inch.

The square can be used as a marking gauge, straight edge, try square, level, depth gauge, plumb, or mitre square. With a center head attachment, it can be used to locate the center of round objects. With a bevel-protractor head, angles can be marked in degrees. The blade can be used for measuring short lengths.

e. T-Bevel Square

The most common type has a six inch blade with a 45 degree beveled end. The blade has a long center slot which permits its movement to form a T-bevel or angles. It is usually not graduated.

The main purpose of the T-bevel square is to transfer angles, bevels, and chamfers from one stock to another. It can be set an any angle by tightening the blade screw; therefore, several boards can be cut at the same angle.

Transparency No. 3

3. The Description and Use of the Common Types of Rules

a. Zigzag or Spring-Joint Folding Rules

The zigzag rule is usually six feet in length. It is graduated from one inch to one-sixteenth inch and can be read both ways, from left to right and right to left. Some of the more expensive rules have a six inch extension which permits making inside measurements of objects such as door and window facings.

Long measurements may be made with the zigzag rule. It folds every six inches and should be handled with care while folding, due to its being thin and long. The framing square is used to square a board after the rule has been used. Another way to use the rule on boards over 12 feet is to unfold the rule completely, mark off six feet from each end, then mark the center between the two six feet points.

b. Two-Foot Folding Rule

This short folding rule is two feet or 24 inches long, and one-half inch wide. It can be folded down to the length of the zigzag rule, six inches, but it is easier to handle because of only four folds. The graduation lines are the same as those found on the zigzag rule. The long line is one inch, followed by one-half, one-fourth, one-eighth, and one-sixteenth inch.

The two-foot folding rule is used to measure short pieces of boards or short objects. If several short marks are to be made on a stock, it is advisable to turn the rule on its edge, so that the ruled lines touch the stock and make the marks without changing the rule.

c. Bench Rule

The bench or one piece rule is non-folding. It is 24 inches long and 1-1/4 inches wide. It is graduated in sixteenths of an inch on one side and eighths of an inch on the other side.

The rule is used in a similar manner as the short folding rule. The rule is used on its edge for a distance of less than two feet. It is one-fourth inch thick; therefore, edge measurements can be made without difficulty. The rule can be used as a straight edge.

d. Push and Pull Rule

The push and pull rule is similar to a tape in that it rolls inside a round metal case. The metal rule is available in many lengths. The most commonly used length is 10 feet. It is graduated in inches. Only one side of the rule is numbered; but both edges of the numbered side are graduated in sixteenths of an inch. Some rules are graduated for the first few inches in thirty-seconds of an inch. Several types of pull-push rules are equipped with a rewind mechanism.

The push and pull rule is for measuring layout work of both short and long objects. The size of the rule permits it to be carried in the pocket. Curved or irregular surfaces may be measured by this metal rule due to its flexibility. When making inside measurements, the 2 inch metal cast is added to the measurement.

e. Caliper Rule

This rule is used mainly to measure the thickness of materials by taking measurements between the jaws of the rule. Holes and width of cuts can be made by inserting the jaws and reading the inside measurement.

Transparency No. 3

4. Identification and Use of Tapes

a. The Steel Tape

Steel tapes are found in standard lengths of 25, 50, and 100 feet. The tapes are graduated in feet, inches, and usually to one-eighths of an inch.

Tapes are used to make long measurements, and only one person can use the tape effectively if the ring at the end or starting point is hooked in place by a nail or other holding device. The tape is used on foundations, drive layouts, and many landscaping jobs.

b. The Cloth Tape

This tape is found in the same sizes and graduations as the steel tape, 25, 50, and 100 feet being the most common lengths.

The cloth tape can be used in the same manner as the steel tape. It may have a tendency to stretch, but it will not kink, which may be a common problem with the steel tape if it is not used properly. On the steel and cloth tapes, with rings at the end, measurements are read from the tip of the ring.

Transparency No. 4

5. Marking and Reading Devices

a. Marking Gauge - The marking gauge is used to make parallel lines from either the edge, side, or end of a board. The setting of the gauge is made by the use of a rule. A reading is taken from the spur to the gauge head by a rule. It is necessary that the gauge head be pushed forward against the stock so that the spur moves at a slight angle.

b. Other Marking Devices

The combination square serves as a marking gauge by placing the head against the surface of the stock and adjusting the blade to the desired distance. A pencil or sharp, pointed instrument is placed at the end of the blade as it is moved by a pulling motion. Both hands are used to handle the square and pencil.

When using a rule or straight edge, the thumb of finger regulates the distance to project the end of the rule over the board for marking. A pencil or sharp-edged instrument is used at the end of the rule to make a mark as it is pulled forward. Both hands are needed to manipulate the rule and pencil; therefore, the stock should hold firmly by some means, permitting the hands to be free for marking.

When using the thumb or finger as a guide and using only a pencil for marking, it is necessary that the starting point be measured by a rule. This method is less accurate than the use of a marking gauge or a combination square.

Dividers are a device used for making circles, transferring short measurements from a rule, and dividing measurements into equal parts.

Either rules or squares of different types may be used to find the center or even parts on the board. For example, to find the center of a board that is 5-5/8 inches, the 2 inch mark of a rule can be placed on one edge and the 8 inch mark placed on the other edge. The rule will be at an angle on the board, but a mark at five on the rule will be the center. Marks at four and six on the rule will divide the board into three equal parts. Odd numbers can be determined by dividing the number by the desired number of pieces.

Inside measurements may be made by using the extension on the six foot folding rule by placing two bench rules together if the distance is between two and four feet and then taking the overlap readings, or by using two pieces of boards, each end touching the inside of the object (door or window facing) and marking the end of each where they overlap. The distance may be transferred to a rule for making a correct measurement.

The most common marking devices include pencils, knives, awls, and chalk lines. In some cases narrow wood chisels have been used.

References:

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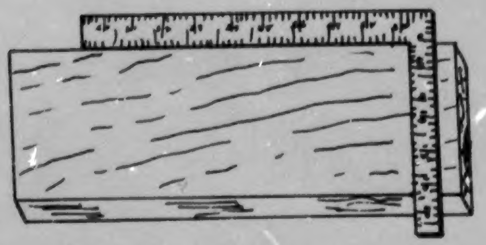
2. Foss, Edward W., Construction and Maintenance for Farm and Home, John Wiley and Sons, Inc., New York, NY, 1960.

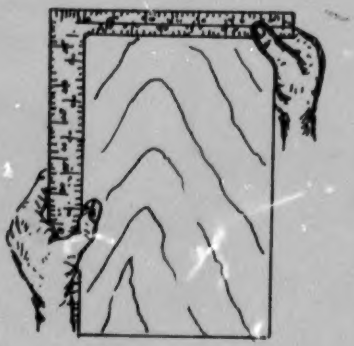
3. Phipps, Lloyd J., Mechanics in Agriculture, The Interstate Printers and Publishers, Inc., Danville, IL, 1967.

4. Wakeman, T. J. and Vernon Lee McCoy, The Farm Shop, The Macmillan Company, New York, NY, 1960.

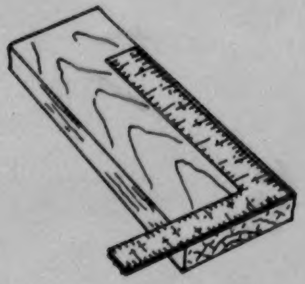
USE OF THE FRAMING SQUARE



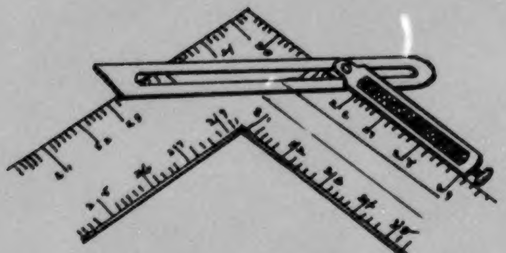
squaring board



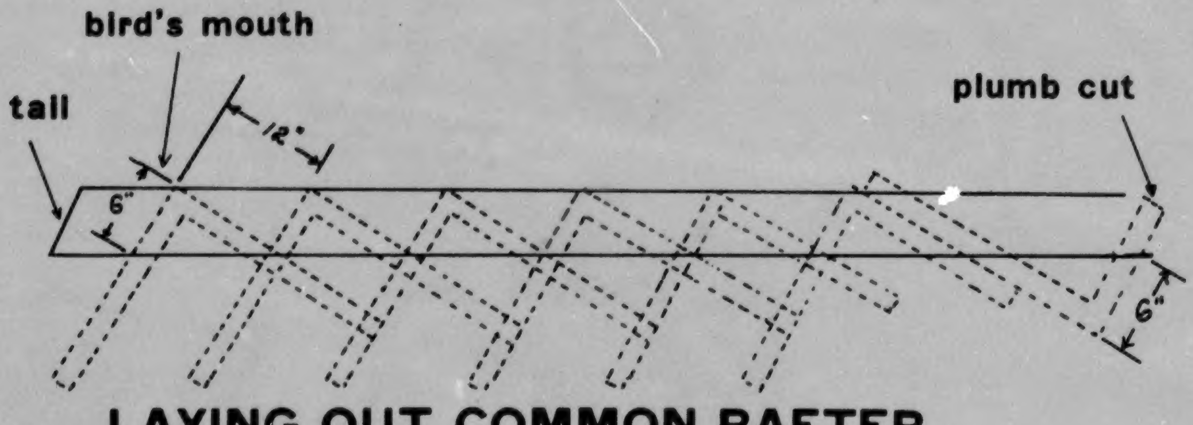
testing board



measuring board

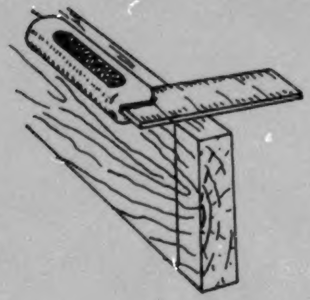


setting T- bevel

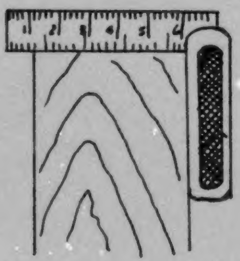

bird's mouth
tail
12"
6"
plumb cut
6"

LAYING OUT COMMON RAFTER

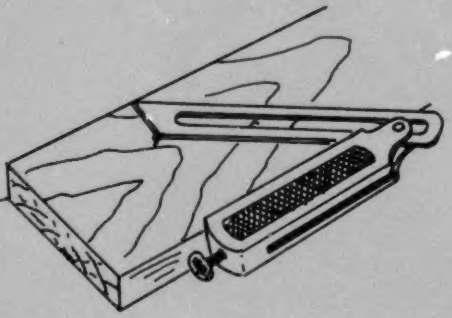
USE OF SQUARES



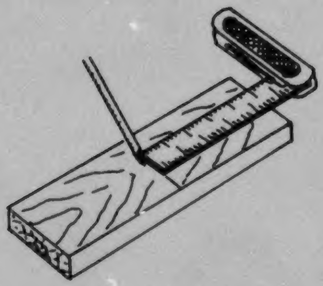
try square edge squaring



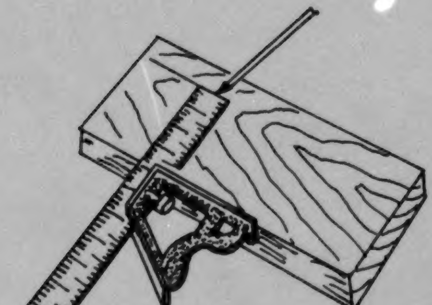
try square testing cut



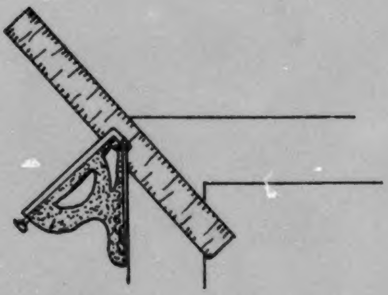
T-bevel marking angle



try square measuring

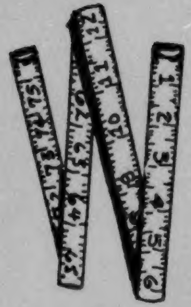


combination marking board

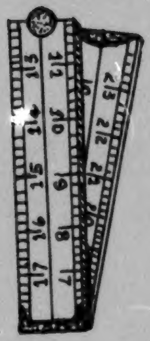


combination testing 45 degree angle

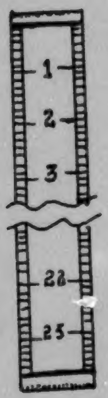
RULES, TAPE AND MARKING GAUGE



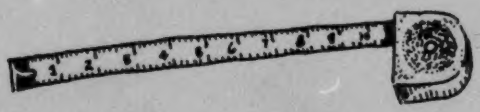
zig zag rule



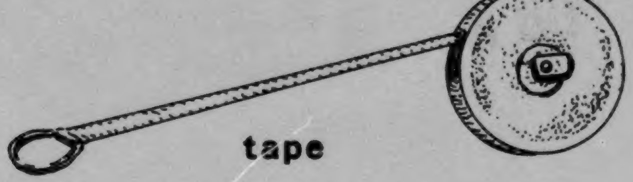
two-foot
folding rule



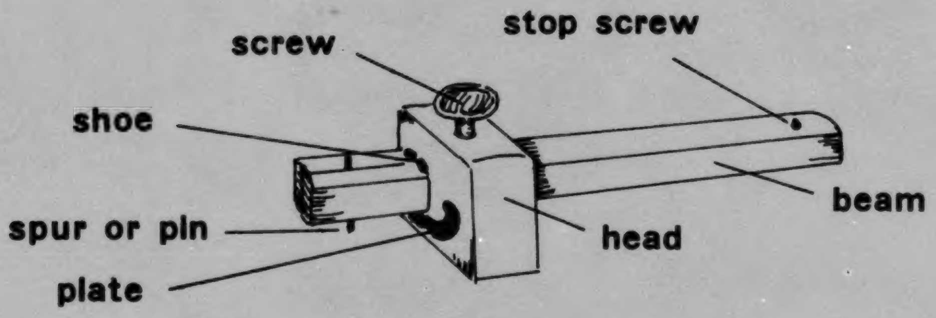
bench rule



push - pull rule

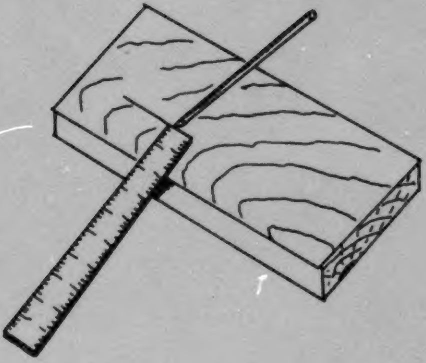


tape

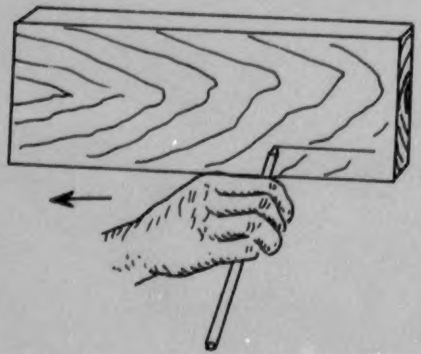

screw
stop screw
shoe
beam
spur or pin
head
plate

marking gauge

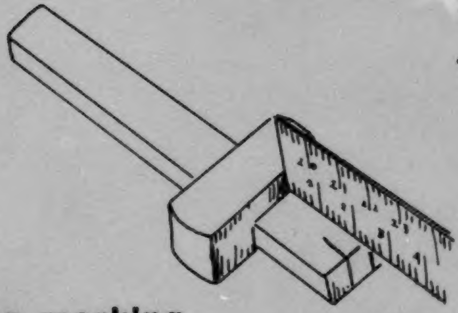
MARKING DEVICES



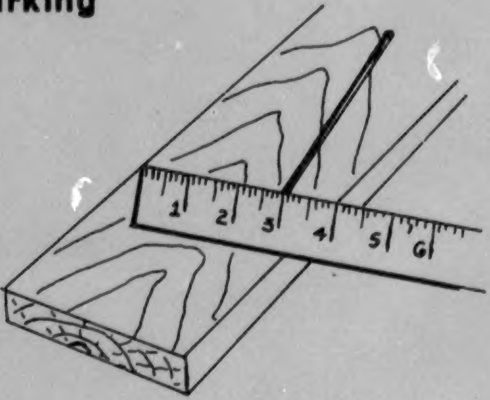
use of rule and pencil for marking



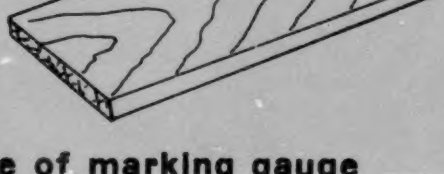
use of pencil only for marking



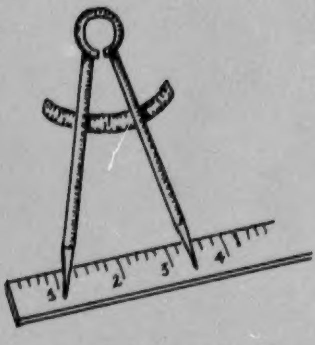
setting marking guage with rule



marking equal portion of board



use of marking gauge



marking circles or transferring distance

AGRICULTURAL MECHANICS

Unit C: Cold Metal Work

Topic 1: Identifying Common Kinds of Metal

Suggested Procedure and Activities: An exhibit representing the different kinds of metals will be helpful during the class discussion.

1. Why Metal Is Important as One of the Commonly Used Materials

a. The need and use of iron and steel has caused this century to be known as the Steel Age. Man has learned to use metals for transportation, buildings, manufacturing equipment of all types, machinery for agricultural and other industries, hand tools, weapons, furniture, appliances, and numerous other purposes.

b. Metal has a tendency to last longer and have more strength than many building materials. Without metal it would be difficult to extract important fuel products. Metal has helped preserve other materials that would otherwise be used for building purposes.

2. Mining and Processing Iron Ore

a. Iron mines are located in several states, but the greatest quantities of iron ore are mined around the Great Lakes region. The ore is mined in two different ways:

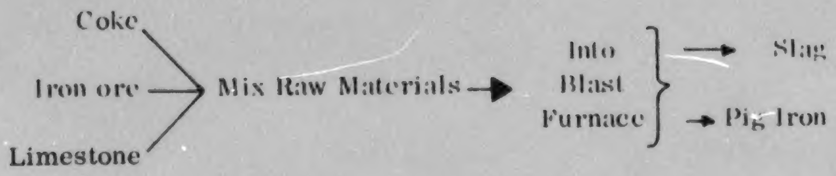
A shaft operates in a hole that has been drilled into the earth.

Ore is dug from an open pit by power shovels.

Iron ore is not a pure metal. As it comes from the earth, it is found mixed with minerals such as sulphur, phosphorus, silicon, and manganese.

b. Iron ore must be freed of nonessential materials before it can be used. The process is as follows:

Coal is used to make coke to be used in the process.



The steps in processing pig iron are:

Iron ore, coke, and limestone are dumped in the furnace.

Hot air is forced from the bottom up, causing the coke to produce the heat to melt the ore.

Impurities are separated from the melted ore by the limestone.

The coke burns away and the oxygen burns from the ore; the iron melts and drops to the bottom of the furnace where it is drawn off. The slag remains on top of the pig iron before it is drawn from the furnace.

Steel is made by either of two methods: the Bessemer process or the open hearth process. In the Bessemer process the molten iron is poured from the blast furnace into a pear-shaped vessel, and carbon and manganese are added to produce steel. In the open hearth process, scrap iron, pig iron, and limestone are heated to produce steel. Carbon and manganese are added to the molten liquid to harden the steel.

Alloy, stainless steel, and other steels are produced in electric furnaces.

Metals are either poured into molds or rolled into various shapes.

3. Types of Irons and Steels and Their Uses

a. Types of Irons and Their Uses - There are two different types of irons; cast iron and wrought iron. Cast iron is made up of three different types which include gray, white, and malleable. All cast iron is considered very brittle. It contains large amounts of carbon and some impurities. Wrought iron contains few impurities and is low in carbon content. Both cast and wrought iron are made from pig iron. The uses are:

Cast Iron - Gray cast iron is used to make engine bases and blocks. White cast iron or chilled iron is used for bearings, plow shares, and moldboards for plows. Malleable cast iron is used to make small parts of machinery, pipe fittings, and some machine guards. Gray and white cast iron cannot be bent, whereas malleable iron can be bent to a certain extent without breaking.

Wrought Iron - This special iron has most of the carbon removed. In fact the phosphorus, manganese, and silicon contents are very low in wrought iron. Sulphur is an undesirable material in the iron. Wrought iron is used to make nails, wire, bolts, pipe, scrap iron, chains, and rivets.

b. Types of Steel and Their Uses - If iron has a carbon content below 1.7% it is usually considered to be steel. Most of the steel production is accomplished by the open hearth process. Steel hardness or softness is determined by the carbon content, which is in the form of iron carbide, and the rate of cooling after it has been heated.

Mild Steel - Mild steel is a soft steel with a low carbon content ranging from about 0.1 to 0.3% carbon. It has many uses due to its ability to be easily sawed, hammered, filed, or ground. Also it is easily welded and bent. It is used to make trusses, braces, and bolts for machinery.

Machinery Steel - Mild steel is softer than machinery steel. Machinery steel has a higher carbon content (o.5 to 0.6%) than mild steel. It is used to make machinery parts such as plows, beams, and braces that are heavier than mild steel braces. Shafts and some axles are made of machinery steel.

Tool Steel - This steel has a high carbon content. It is also made from pig iron, but it goes through a lengthier refining process than either mild or machinery steel. Usually, it is refined in an electric furnace where the melting and refining is easily controlled. Tool steel may have a carbon content from 0.5 to 1.5%; for example, the carbon content of cold chisels may be as high as 0.9%. This steel is used to make cutting tools, hammers, taps, and dies. It is almost free of impurities and is difficult to weld if it is very high in carbon content. Another use of high carbon or forged steel is crankshaft construction for engines.

Alloy Steel - Metals such as chromium, silicon, nickel, manganese, tungsten, and copper are added to steel to live it certain desirable characteristics. Stainless steel is made by adding chromium to steel. It may also contain nickel. High speed drill bits contain tungsten (metallic element used to harden steel). Alloy steel containing chromium, nickel, and copper has corrosion-resisting properties.

c. Working with Iron and Steel - Cast iron is brittle and hard; therefore, it can be welded with reasonable care except by the forage method. Due to its having a coarse grain, it can be drilled, sawed, and filed easily. Wrought iron is also easy to weld, drill, and saw. Unlike cast iron, it can be threaded without the danger of breaking. Also, it can be bent to a certain extent. Working with steel depends upon the type of steel that is being used. Soft and medium hard steel can be welded, drilled, and cut fairly easily, but hard or high-carbon steel requires special tools to drill, cut, bend, or shape it. Steel that contains alloys of different types will affect the procedure of working it. A copper alloy steel can be cut, drilled, and bent easily, but a tungsten alloy is hard to drill, cut, bend, or weld.

4. Nonferrous Metals and Their Uses

   a. Aluminum is a very popular metal that is used for agricultural and home purposes. It is a metal produced from ore bauxite. Aluminum is used for building sidings, roofing, casting in motors, wire, and conductors used in electrical work.

   b. Copper is not as light in weight as aluminum, but it is equally as important. Its more important uses are in plumbing and electrical wiring. When copper is mixed with zinc or tin, it becomes brass or bronze alloys. Brass is used mainly for hardware. Bronze is used for bearings in machinery.

   c. Lead and tin are considered soft non-corrosion metals that are used for piping waste materials and soldering.

   d. Zinc-base metals are heavier than aluminum, and they are used mainly for plating other metals (galvanizing), electric tools, and certain fuel parts on engines.

   e. Magnesium is actually lighter than aluminum. It can be dangerous around fires. It is used in incendiary bombs, for ladders, and for chain saws.

   f. Tin is a soft, silvery metal. It is found in the raw form as tin ore. This nonferrous metal is used to coat cans, utensils, and metal roofing.

   g. Bronze is considered a hard base alloy. It lasts longer than brass and is used for machine bearings, medals, bells, propellers, and statues. The penny or one-cent coin is bronze. It is a copper-base alloy that sometimes contains zinc.

   h. Brass is an alloy of copper and zinc. It is yellow and ranges from 60 to 90 percent copper and 10 to 40 percent zinc. This metal is used for musical instruments, house hardware, and small gears.

   Transparencies Nos. 1 and 2

5. How to Identify Metals by the Spark Test (Transparencies Nos. 1 and 2)

References:

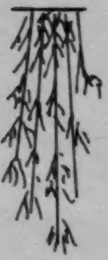
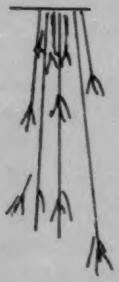
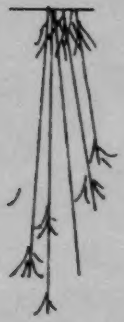
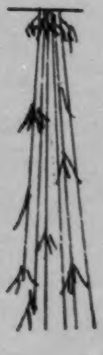
1. Foss, Edward W., Construction and Maintenance for Farm and Home, John Wiley and Sons, Inc., New York, NY, 1960.

2. Ludwig, Oswald A., and Willard J. McCarthy, Metal Technology and Practice, McKnight and McKnight Publishing Co., Bloomington, IL, 1969.

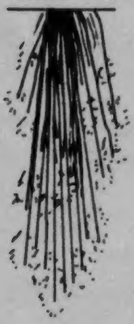
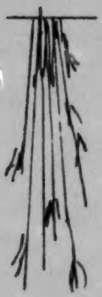
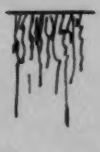
3. Phipps, Floyd J., Mechanics in Agriculture, The Interstate Printers and Publishers, Inc., Danville, IL, 1967.

4. Wakeman, T. J. and Vernon Lee McCoy, The Farm Shop, The Macmillan Company, New York, NY, 1960.

SPARK IDENTIFICATION ON HIGH SPEED GRINDER

METAL	SPARK STREAM	COLOR STREAM LENGTH
White and Gray Cast Iron		Top-Red Bottom-Straw Yellow 20" to 25"
Malleable Iron		Straw Yellow About 30"
Wrought Iron		Top-Straw Yellow Bottom-White About 65"
Mild Steel		White About 70"

SPARK IDENTIFICATION ON HIGH SPEED GRINDER

METAL	SPARK STREAM	COLOR STREAM LENGTH
Tool Steel		White About 55"
Alloy Steel		Top-Straw Yellow Bottom-White Length Varies
Nickel		Orange About 10"

AGRICULTURAL MECHANICS

Unit C: Cold Metal Work

Topic 2: Cutting Cold Metals

Suggested Procedure and Activities: A small exhibit of metal cutting hand tools and the use of transparencies may be helpful during the class discussion.

Transparency No. 1

1. Measuring and Marking Cold Metal

a. The most common measuring devices and their uses are listed below:

The metalworker rule is made to measure metal. It is six inches in length and is graduated in 1/64, 1/32, 1/8, 1/4, 1/2, and 1 inch.

The framing square, try square, and combination square are important measuring devices for metal work.

Where it is necessary to use long measurements, the push-pull rule and steel tape rule are used. The push-pull rule is found up to 10 feet in length, and the steel tape rule is from 25 to 100 feet in length.

If a high degree of accuracy is needed in measuring metal, a micrometer may be used. It can measure to the thousandth of an inch. Calipers are also instruments for measuring metal. The caliper is usually used with a rule or micrometer since the caliper does not have dimension numbers.

b. Marking devices for metal are as follows:

The combination square serves as a marking gauge. It has a marker (a small steel awl with a fine point) in the head that is used to mark metal.

The scratch awl is usually used with a straight edge. Its fine needle point can be placed against the measuring tool for accuracy.

Scribers are marking tools made of high carbon steel. They are used for making lines on metal in the same way the common awl is used.

Dividers are sharpened so that either of the two metal points can be used to sit on the metal or scratch the metal. They can be used to mark circles, to mark equal lengths, and to divide circles.

The center punch is used to mark the center of a hole and to make an indentation in the metal for a drill bit.

A prick punch is sharp and pointed (15 degree angle to its center). It is used in layout work by locating hole center, marking reference points, and making lines. Paper patterns can be placed on metal and the pattern transferred to the metal stock by piercing the paper as necessary.

2. Cutting Stock

a. Hack Saw - Hack saw frames will usually take blades from 8 to 12 inches in length. The blades are available with 19, 24, and 32 teeth per inch. They are 1/2 inch wide and .025 inch thick.

Suggestions for using blades are:

When cutting mild steel or cast iron over 1/8 inch thick, use a coarse blade (18 teeth per inch).

Hard steel, pipe, and heavy sheet metal can be cut with a medium blade (24 teeth per inch).

Thin sheet metal and tubing should be cut with a fine blade (32 teeth per inch).

High speed blades are usually not necessary for ordinary work. A high-carbon or tungsten-alloy blade is tough enough to resist breaking and does most jobs of a hacksaw. The high carbon blade is less expensive than an alloy or high-speed blade.

Transparency No. 2

Steps for inserting the blade are:

The blade is placed in the frame with the teeth pointing away from the handle.

Tighten the blade in the frame; the proper amount of tension will prevent the blade from snapping.

Retighten the blade after it has been used for a short time.

The steps to follow in making the cut include:

Mark the metal to be sawed and place it in a vise. The mark should be placed near the jaws, especially if the metal is thin. It may be necessary to use boards between the vise jaws to prevent scarring the work. Mark over the original mark with a file.

Hole the saw with both hands and start the cut by pulling it toward the body (backward stroke). The kerf may be started without filing a notch on the metal. As the saw is pulled backward a very small amount of pressure should be applied.

The right amount of pressure should be applied as the saw is pushed forward. No pressure should be used on the back stroke after the saw begins cutting.

Steady strokes from 40 to 50 per minute are considered the correct speed for sawing.

Never start a new blade in an old cut. The teeth are set; therefore, the cut is narrower than the new blade. One stroke may ruin the teeth.

Transparencies Nos. 3 and 4

b. Cold Chisel - There are four common types of cold chisels used for cutting metal: standard flat, diamond point, cape, and round nose. The most commonly used is the standard flat chisel. It is used to cut sheet metal, bolts, nuts, rivets, and rods. The diamond point chisel is used for cutting triangle grooves or for making square corners in grooves. The cape chisel is used to cut out rectangular grooves or channels. The round nose chisel is used similarly to the diamond point in that oil grooves or channels can be made by its use. It cuts an oval groove.

The steps in cutting flat metal are:

Mark the metal with an awl, soapstone, scriber, or chalk.

Metal 1/8 inch thick or less can be placed in the vise and cut with a flat chisel by holding the chisel at about a 60 degree angle. The cutting line should appear just above the jaws of the vise.

Place the chisel at one side of the metal to start the shearing point; at the same time place the cutting edge at an angle to the work. Drive the chisel with a machinist's hammer. Use entire hand to hold chisel firmly.

For metal that is thicker than 1/8 inch, a 3/4 inch wide chisel and a 2-1/2 pound hammer should be used. Larger chisels and hammers may be used as the metal increases in thickness.

Thick metal should be placed on the cutting ledge of the anvil. First, cuts should be made on each side of the metal. The cuts are made from the side to the center.

The metal is turned over and the same cut is made on the reverse side. After the cut is completed on both sides without cutting through the metal, it may be bent back and forth until it breaks.

The steps in cutting round iron are:

After the iron is marked, it should either be clamped in a vise or held on the cutting ledge or shoulder of the anvil for making the cut.

The rod or round iron should be cut from both sides, each cut being 1/3 the distance through the rod.

Break the rod at the point of the cut by bending it back and forth across the vise jaws or over the edge of the anvil.

After some practice the chisel head can be hit with heavy blows without hitting the hand. The chisel should be grasped above the bevel and held loosely in order that the hand will not be endangered if the hammer slips off the chisel head.

The standard flat chisel is sharpened at about a 70 degree angle. Soft metals and sheet metals can be cut more rapidly if the chisel is sharpened to a 45 degree angle. Heavy sheet metal such as oil drums and metal water troughs can be easily cut with a slitting chisel.

c. Bolt Cutters - One of the fastest methods of cutting round iron from about 3/16 to 3/4 inch thick is to use a bolt cutter. This metal cutting tool should be used properly; that is, the bolt or rod cutting capacity that is stamped on the handle should be observed.

The procedure for using the bolt cutter is as follows:

The rod or bolt is placed as far back in the jaws as possible; the handles are pulled together without twisting. When using large cutters, one handle should be braced against the floor. Note: Hardened steel should not be cut in the bolt cutter.

d. Cold Cutters - Cold cutters function the same as cold chisels except for the fact that the cold cutter resembles an anvil hardy on one end and a hammer on the other end. It also has a handle which is used to keep the cutter on the metal while it is being hit with a large machinist's hammer. It takes two students to use a cold cutter, whereas one can cut with a cold chisel.

The cutting procedure is as follows:

> The marked metal is placed on the anvil shoulder. The metal is cut about 1/3 of the way through on both sides. It is bent back and forth over the edge of the anvil until it breaks.

3. How to Cut Different Types of Metal

   a. Tool Steel - It is advisable to test tool steel to determine whether or not it is in the softened stage before attempting to cut it. The saw blade or chisel may be dulled if the steel is too hard. Usually tool steel is nicked with a high carbon hack saw blade. Tool steel can be broken by sawing about one-fourth the way through the rod or bar and then breaking it in a vise with the hammer. Heavy hammer blows should be directed toward the backside of the vise.

   b. Thin Metal - Very thin metal may be cut with a hack saw by placing it between two pieces of board in a vise. The cut should be made through the boards and metal. The boards and metal can be clamped to a table top instead of being placed in a vise. Sheet metal is cut with metal snips and metal cutting shears. Snips are used very often in cutting this metal. Sheet metal of 20 gauge or less can be cut with the scissor-like tool if it is soft.

References:

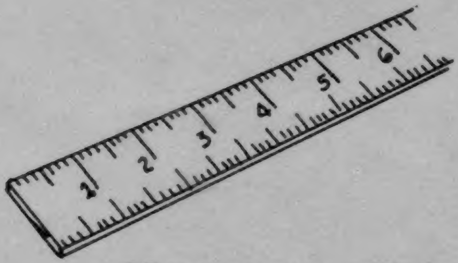
1. Foss, Edward W., Construction and Maintenance for Farm and Home, John Wiley and Sons, Inc., New York, NY, 1960.

2. Ludwig, Oswald A. and Willard J. McCarthy, Metal Technology and Practices, McKnight and McKnight Publishing Co., Bloomington, IL, 1969.

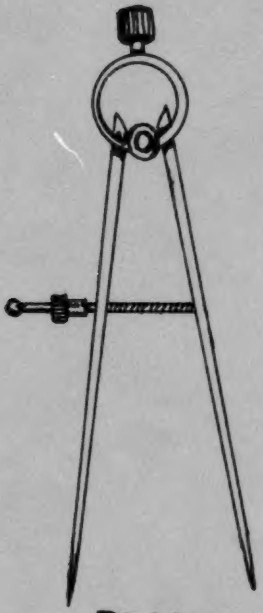
3. Phipps, Floyd J., Mechanics in Agriculture, The Interstate Printers and Publishers, Inc., Danville, IL, 1967.

4. Wakeman, T. J. and Vernon Lee McCoy, The Farm Shop, The MacMillan Company, New York, NY, 1960.

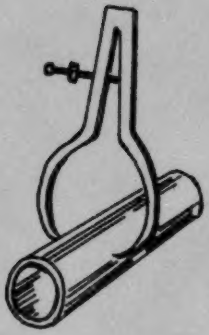
MEASURING AND MARKING METAL



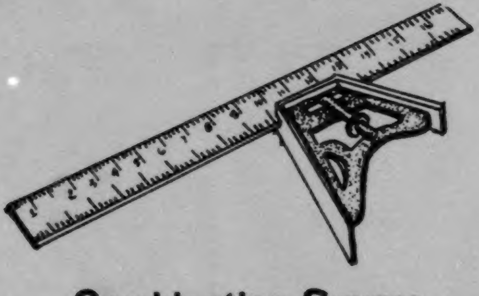
Metalworkers Rule



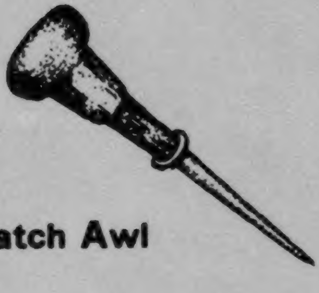
Dividers



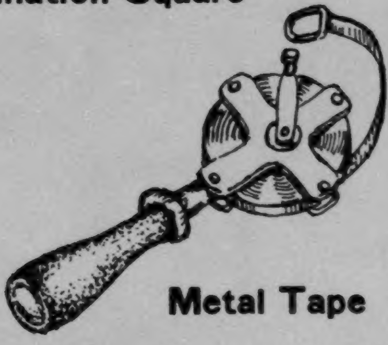
Calipers-Outside



Combination Square

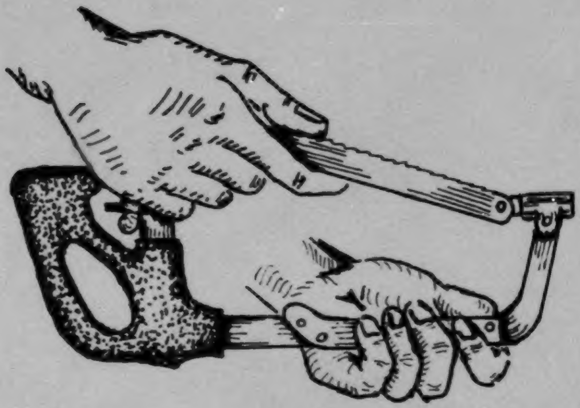


Scratch Awl

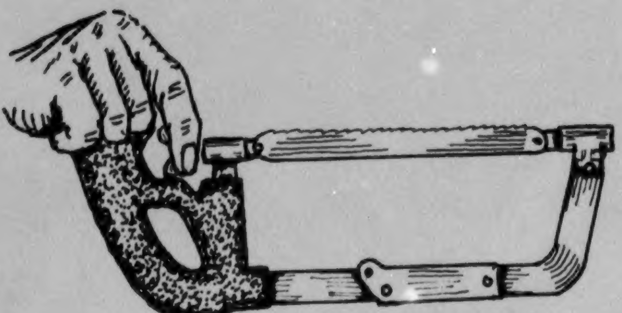


Metal Tape

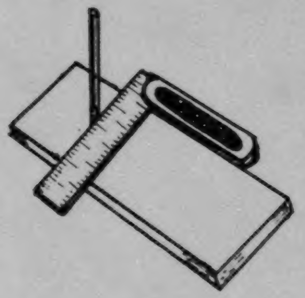
CUTTING COLD METAL WITH HACK SAW



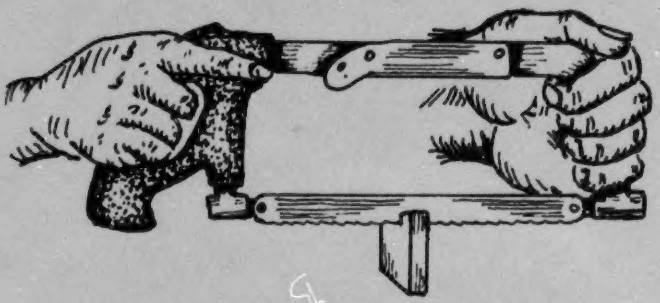
Inserting Blade
Teeth Forward



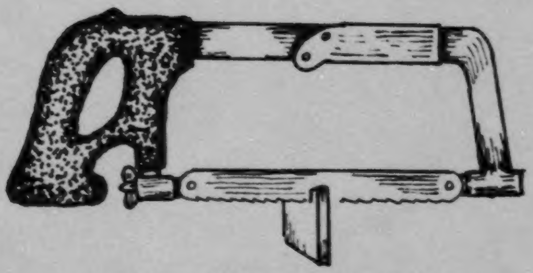
Tighten Blade
Firmly



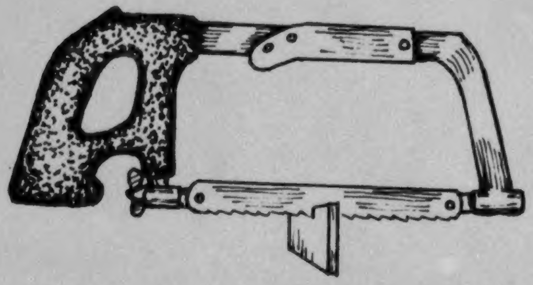
Marking Stock



Using Both Hands

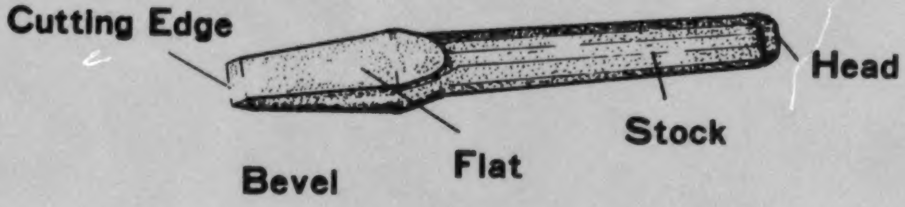


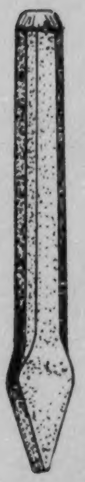
Use Pressure Forward Stroke



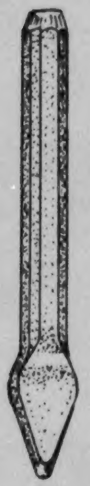
No Pressure On Back Stroke

USE OF COLD CHISEL

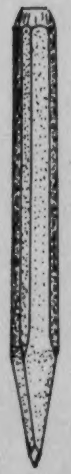

Cutting Edge
Head
Stock
Flat
Bevel



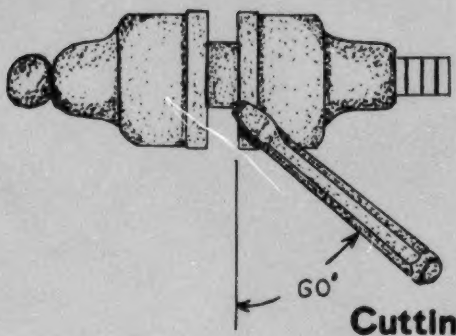
Cape



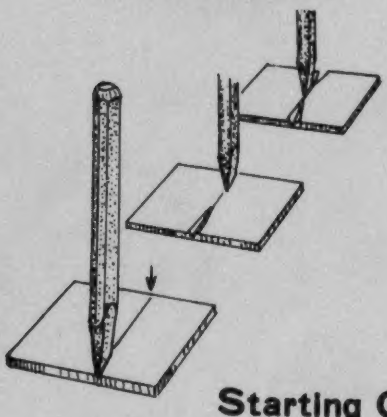
Round Nose



Diamond Point

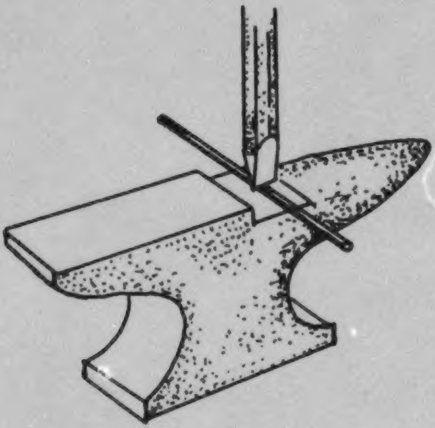


Cutting Angle

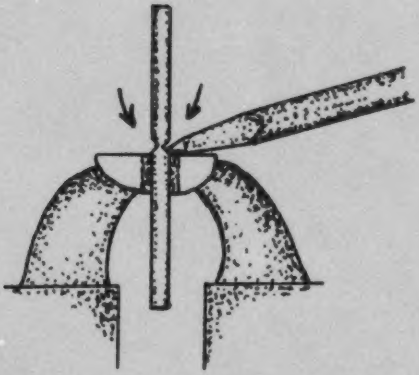


Starting Cut

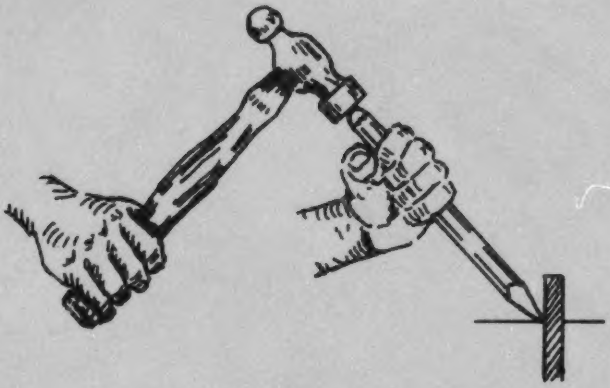
USE OF COLD CHISEL AND BOLT CUTTER



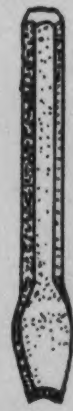
Cut Metal on Anvil Ledge



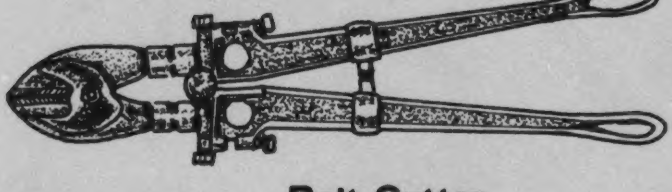
Cut Two Sides of
Rod Before Breaking



Use of Ball Pein Hammer with Chisel



Slitting Chisel



Bolt Cutter

AGRICULTURAL MECHANICS

Unit B: Cold Metal Work

Topic 3: Filing Cold Metal

Suggested Procedures and Activities: Different types of files may be shown to the class during the discussion. Transparencies on the use of the file may contribute to the discussion.

1. The Purposes of Filing Cold Metal

a. Shaping Cold Metal - The file is used for smoothing and shaping metals. Shaping actually includes three types of file use: sharpening of tools, smoothing metal surfaces, and cutting metal to the desired form and dimension.

b. Testing Metal - The hardness of metal can be determined by using a regular mill file. The degree of hardness will determine the type of metal cutting tool and/or the type of hack saw blade to use in the cutting operation.

2. Selecting the Proper File

Transparency No. 1

a. The parts of a file include:

Point
Heel
Tang

Body
Edge teeth
Belly

b. File Sizes - File sizes are determined by the length of the file (in inches) excluding the tang or the distance from the point to the heel. A 10 inch mill file is used for general purposes. A 12 inch flat file is best for tough work.

c. File Teeth - There are two major kinds of file teeth. The single-cut file has chisel-like teeth running at an angle across the belly and body of the file. Double-cut files have two sets of teeth or chisel cuts that cross each other. The double-cut file cuts faster than the single-cut file, but it leaves a rough surface.

Transparency No. 1

d. Grades of Coarseness in Files - The six grades of coarseness include:

Rough	Second-cut
Coarse	Smooth
Bastard	Dead-smooth

The most commonly used files are the bastard, second-cut, and smooth. File coarseness is also determined by length. For example, a 10 inch smooth-cut is coarser than a 6 inch second-cut.

Transparencies Nos. 1 and 2

e. File Shape - The shape or style is determined by their different uses. The most common are mill, flat, square, round, half-round, and taper or three-cornered files.

Mill files are made with only single-cut teeth. They range in size from about 4 to 16 inches. They are widely used.

Flat files are double-cut about 4 to 16 inches in length. They are tapered similar to the mill file and are widely used for surface filing.

Square files have four filing sides instead of two as found on the mill and flat files. They are used mainly for filing slots and surface filing.

Round files are usually used to file round or curved surfaces. These files are tapered from the shoulder to the point.

Half-round files have one flat side and one round side. They are always double-cut on the flat side. They can be used to file flat or curved surfaces.

Tapered files are found in many shapes. The triangle, cantsaw, and crosscut files are the most popular. The tapered files are used for filing saws. The web and pruning saw files have double triangle or diamond shaped sides. The crosscut saw file has a round back with two flat sides.

3. The Most Important Methods Used in Filing

a. How to Hold a File After the Tang has been Fitted to a Handle

The handle is held in one hand by placing the thumb or forefinger on top of the handle and gripping the handle firmly with the fingers.

The other end of the file is held between the first two fingers and thumb, applying light to moderate pressure as needed. If heavy pressure is required, the file is held by the fingers and the back part of the thumb.

The file can be held more securely if the stock is clamped in a vise to accomplish better work. Vibration may damage the file teeth. If there is a possibility of the file slipping off the stock and marking or damaging the jaws of the vise, the stock should be clamped between two pieces of board.

b. Steps to Follow When Using a File

The stock (metal) should be clamped slightly above the jaws of the vise to eliminate vibration while filing. The area to be filed on the stock should be about elbow height. Chattering can be eliminated if the stock is placed near the jaws of the vise.

The proper file should be selected to cut the stock. For example, if the surface is to be filed flat, a flat file should be used.

Usually the best position to file a stock is to stand at one side of it. Stand facing the work so that pressure can be applied on the forward stroke.

For flat surface filing the metal should be stroked by holding the file at a 90-degree angle to the side of the stock.

Make a slow full-length stroke by placing the file point on the stock and push it forward; lift it on the back stroke. Moving the file back and permitting it to slide over the metal will dull the teeth faster than pushing the file forward. About 30 strokes per minute is the proper speed to file metal.

Long surfaces can be kept flat if the filing is done diagonally on the stock. The work should be checked during the filing process with a proper type of square to see if a desirable cut is being made. A T-bevel square can be used to check the accuracy of square (90 degrees) stocks.

Transparency No. 3

c. A Fine Finish is Made on the Surface by Drawfiling

After the stock has been clamped high enough in the vise to clear the fingers, each end of the file is grasped and the file is placed on the metal nearest the body. Use a mill file for drawfiling.

Steady pressure is applied as the file is pushed forward. No pressure should be applied to the file if it is dragged back over the work. Actually, when drawfiling the file is pushed sideways for cutting.

Hold the file flat while the moderately slow strokes are being made on the stock.

Use a wire brush to keep the file teeth clean. The file may be partially cleaned by tapping it on the work bench. The file length can be used by using a different place on the file for each forward stroke.

d. A Method of Testing Metal for Hardness - The metal stock is held firmly as the file is pushed forward over its surface an inch or two.

Extremely Hard Metal - The file will slide over the metal leaving the file dull and shiny. The file must be harder than the material being cut. The file should not be used on hardened steel.

Hard Metal - The file may barely cut into the metal but it is dulled if considerable pressure is used.

Medium Hard Metal - This type of metal makes up a quantity of the cutting tools; therefore, it is filed.

Soft Metal - The file teeth bite into the metal very easily and become clogged with metal particles. Soft metal is cut very easily and does not dull the file. Very little pressure is applied while filing soft metal.

Cast Iron - An old file should be used to cut through the outer surface before using a new file. The outer surface of cast iron is considered hard. If scale is present, it should be removed with a chisel and hammer before attempting to file the surface.

Transparency No. 3

4. Cleaning and Care of the File

a. Cleaning the File - Small metal chips clog the teeth of a file at the time it is pushed over the metal surface. These small chips tend to scratch the surface being filed, thus the process of cleaning should be followed during and after the filing job is complete. Small particles of metal are more easily removed if the file is rubbed with chalk before filing. This is a practice to use when filing soft metals. A regular file card (brush) is used to clean the teeth. Brushing should be parallel to the teeth.

Transparency No. 3

b. Care of the File - Files should be stored in racks away from other metals. If they rub or fall against other files and tools, the teeth will be damaged. Files are very brittle and may be broken if allowed to fall on concrete floors or other metals. They should also be kept away from oil and paints due to these materials clogging the teeth. Most files should be stored in a dry place; moisture may cause the file to corrode.

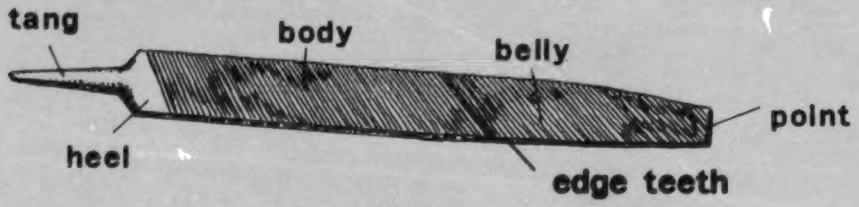
References:

1. Ludwig, Oswald A. and Willard J. McCarthy, Metal Technology and Practice, McKnight and McKnight Publishing Co., Bloomington, IL, 1969.

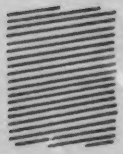
2. Wakeman, T. J. and Vernon Lee McCoy, The Farm Shop, The MacMillan Company, New York, NY, 1967.

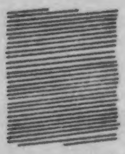
3. "Farm Metal Work," University of Illinois, Urbana, IL.

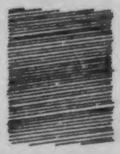
SELECTING FILES


tang
body
belly
point
heel
edge teeth

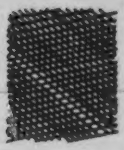
SINGLE CUT TEETH

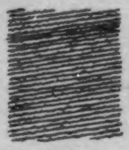

bastard cut

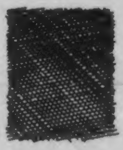

second cut


smooth cut

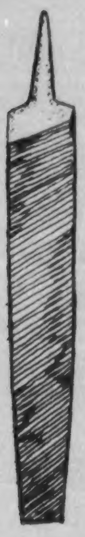
DOUBLE-CUT TEETH

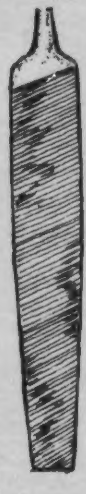

bastard cut

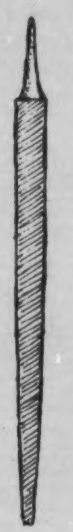

second cut


smooth cut

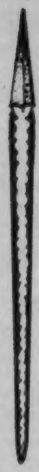
TYPES OF FILES


mill

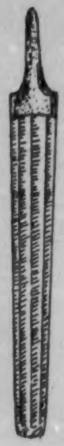

flat


square

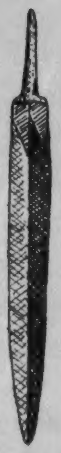
SELECTING AND USING FILES



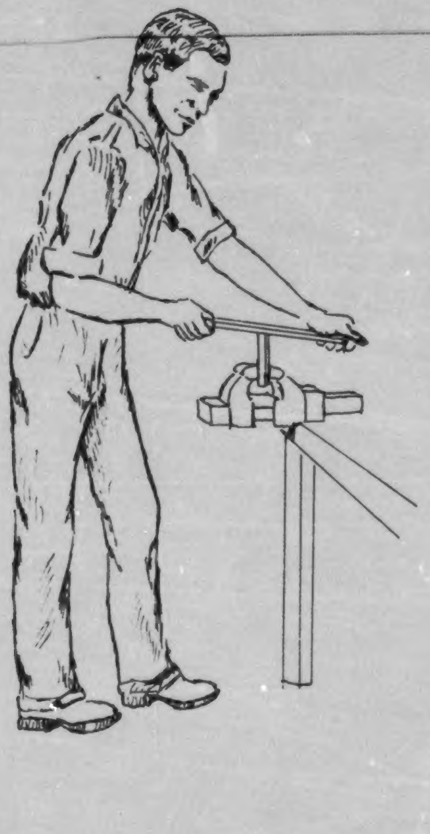
round



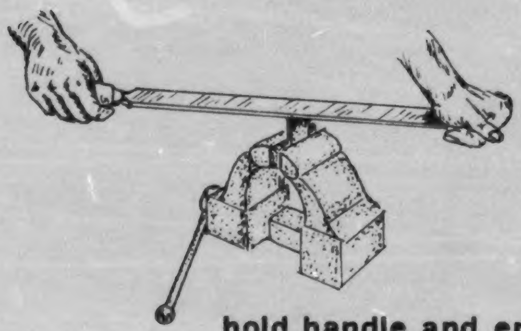
half-round



tapered

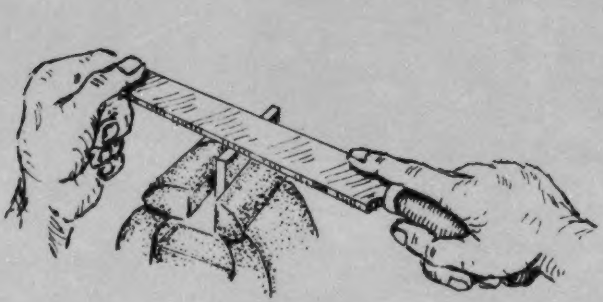


position for filing

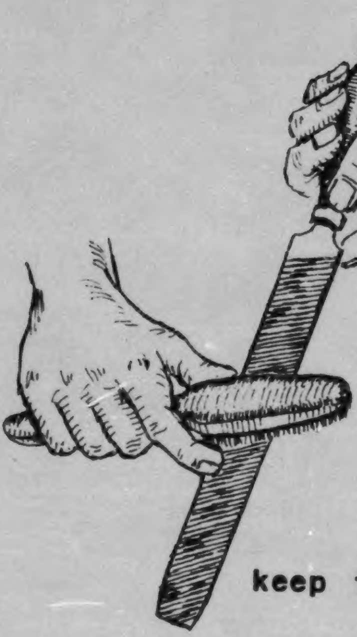


hold handle and end firmly-heavy work

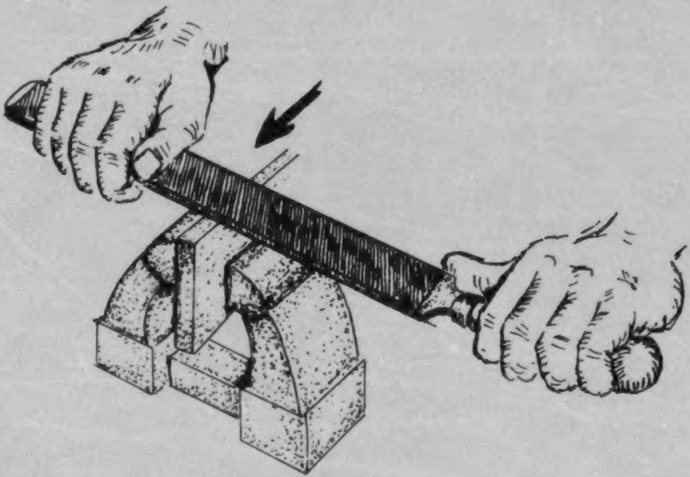
FILING PRACTICES



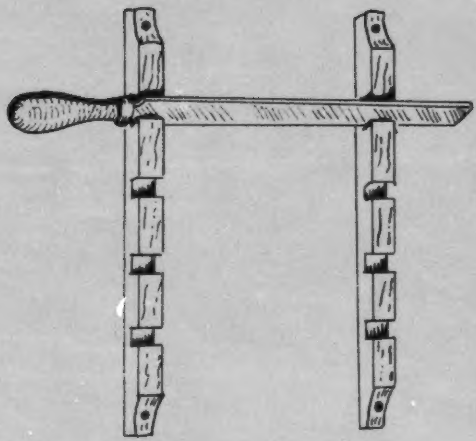
hold handle and end firmly-light work



keep file clean



drawfiling



proper storage for files

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Agricultural Education

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AGRICULTURAL MECHANICS

Unit C: Cold Metal Work

Topic 4: Bending and Shaping Metal

Suggested Procedures and Activities: The transparencies may be helpful during the class discussion. Part of the hour allotted to the lesson may be used as demonstration time.

1. Purposes of Bending Cold Metal

a. Much of the ornamental iron work is accomplished through working with cold metal. There are numerous projects that can be made in the agricultural mechanics shop by bending and shaping cold metal. Some of these projects are braces for farm equipment, gate and door hardware, shelf framing and supports, metal projects requiring ornamental design, and hardware for truck and trailer beds.

b. Flat iron and bars can be bent and shaped up to 3/8 inch in thickness without heating. Round iron can be bent up to about 5/8 inch in diameter. Thick metal, both flat and round iron, should be heated before bending. It takes less physical strength to bend and shape hot metal than cold metal. If the metal is too thick, or too hard, extra stress is placed upon the vise, jigs, and other equipment used to shape it. Good judgment, therefore, must be used in determining whether or not heat is necessary for shaping the metal.

2. Tools Necessary for Bending and Shaping Metals

a. The most common tools used to shape cold metal include:

Blacksmith's vise
Machinist's vise
Anvil
Bending jigs
Measuring tools
Piece of pipe and rod
Sledge hammer
Blacksmith's hammer
Machinist's hammer
Monkey wrench
Marking tools
Ball peen hammer

b. Tools for shaping metal may be of different size. Flat iron less than 1/4 inch thick can be bent with a 1-1/2 pound hammer very easily, but when the iron exceeds 1/4 inch in thickness, a 2-1/2 pound hammer may be necessary to shape the metal. It is very important to use the proper size jig; otherwise, it may be damaged if the metal exceeds the size recommended for the jig.

Generally, metal bending should be a type of work that requires the use of heavy duty blacksmith's or machinist's vises. The sledge hammer should not be used against a vise, and it should not be used on the anvil if the weight exceeds the weight of a heavy machinist's hammer. Heavy duty monkey wrenches are preferred to light weight wrenches.

3. The Types of Iron Used to Make Objects of Projects

   a. Flat iron that is used for making objects or projects by bending or shaping is usually black mild steel. It cannot be hardened due to its low carbon content. It may be known as blacksmith's steel, soft iron, and machine steel. It can be found in various widths and thicknesses.

   b. Round iron, which is more commonly known as rod steel or rod iron, and square rod iron or bar shaped iron of the mild steel type is bent in a similar way as flat iron for objects or projects.

   c. Angle iron is molded into the angle form to give it strength; therefore, it is bent in a shop to form corners. Much of the angle iron is made of mild steel, although some angle iron is made of wrought iron.

   Wrought Iron - This is a tough malleable steel that can be bent and shaped in the same way as mild steel. In fact, flat, round, and bar wrought iron is used to make objects and projects in Agricultural Mechanics.

Transparency No. 1

4. How Metal is Bent and Twisted

   a. The procedure for bending metal is listed below:

   Measure and mark the place for bending or shaping.

   The metal is placed between metal fillers in the jaws of a heavy duty vise. The fillers are to protect the metal from being marred, a practice that is not always necessary.

   Use a ballpeen or machinists' hammer to bend the metal to the desired angle. Metal should be bent from the top of the vise.

   Check the degree of angle with a try square, T-bevel, or a template during the operation.

   Make a round bend (an eye) by following the steps listed below:

Select a piece of round stock (pipe or rod) the same diameter as the eye desired.

Place the flat metal and round stock in the vise. The flat metal should extend at least half way the distance of the diameter of the round stock.

Bend the metal over the round stock which is level with the vise jaws by aid of a hammer.

Extend the bent end of the flat stock to the bottom and center of the round stock and repeat the bending step.

Place the end of the U-shaped stock at the top edge of one vise jaw and repeat the bending step for the third time. Each time the flat stock is placed in the vise, the straight part should be parallel to the vise jaws.

If the straight part of the flat stock is bent, the stock is placed parallel to the inside of the vise jaw before bending. A hammer must be used in the first three bending steps.

b. The procedure for twisting metal is given below:

It is necessary to select metal stock longer than the exact measurement needed because twisting shortens the stock. Cut the stock to the proper length after it is twisted.

Clamp the bar or flat iron in the vise between two metal fillers. The two ends that are free of the twist should be held by the vise and wrench at the same distance from where the twisting will begin.

Use a monkey wrench to twist the flat or bar metal the desired number of turns. Proper twisting will give the metal strength, whereas excessive twisting will cause the metal stock to be weaker.

When twisting long metal stocks, a close fitting piece of pipe slipped over the stock will prevent it from bending. The pipe should be the length of the twist.

Transparency No. 2

5. Bending and Shaping Metal According to a Drawing or Pattern

a. Metal ends are usually shaped with a hammer and anvil, plus the use of a file or grinder. To flatten the ends of flat iron, the metal end is placed on the anvil face, and the end is shaped or flattened with a ball peen hammer. If the metal is to be decorated, the peen part of the hammer should be used on the end, or any place on the flat surface. The ends should be shaped before the metal is placed in a vise or jig. The end shape may be drawn on an actual size drawing or pattern.

b. A pattern or actual size sketch is very important to the student when using jigs or bending forks. The steps are as follows:

Use a piece of string or copper wire by starting at one end of the drawn object and follow the pattern through curves and bends to the opposite end. This method of measurement will determine the length of metal needed.

If necessary, the ends should be shaped and peened. The end bend should be started on an anvil.

The bending fork or jig should be placed in a vise and secured firmly.

If the posts are adjustable on the jig, they should be adjusted to the thickness of the stock to be bent.

The curves and angles are formed with the bending jigs or forks by use of the hands, pipe, and hammer. Sometimes it is necessary to slip pipe over the iron to give extra support for applying pressure. Usually, stock that is more than 1/4 inch thick must be bent in a vise.

The object or project should be checked frequently by placing it over the drawing. If a bend is too short, a vise may be used to straighten it.

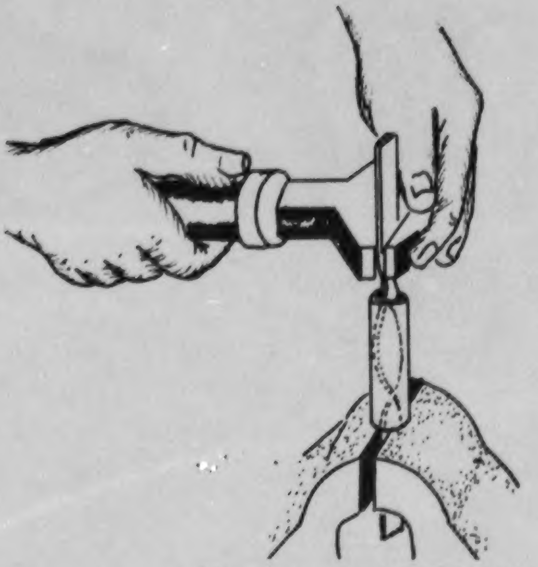
References:

1. Foss, Edward W., Construction and Maintenance for Farm and Home, John Wiley and Sons, Inc., New York, NY, 1960.

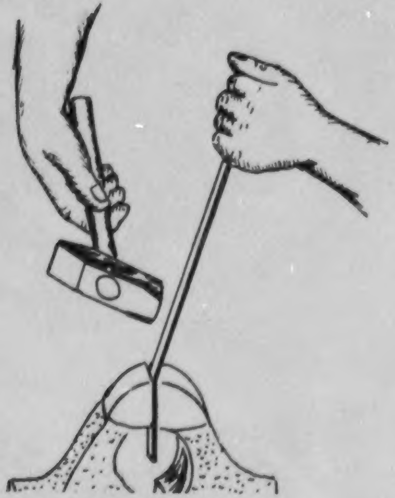
2. Phipps, Floyd J., Mechanics in Agriculture, The Interstate Printers and Publishers, Inc., Danville, IL, 1967.

3. Wakeman, T. J. and Vernon Lee McCoy, The Farm Shop, The Macmillan Company, New York, NY, 1960.

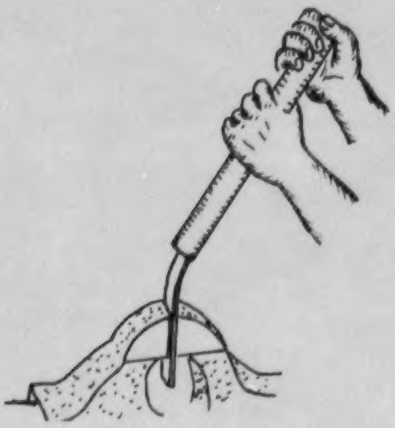
BENDING AND TWISTING METAL



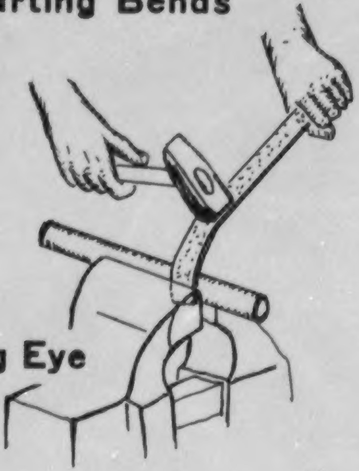
Making Long Twists



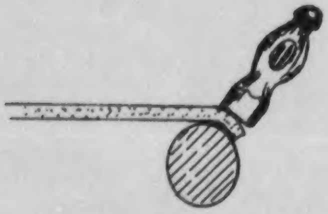
Use of Hammer Starting Bends



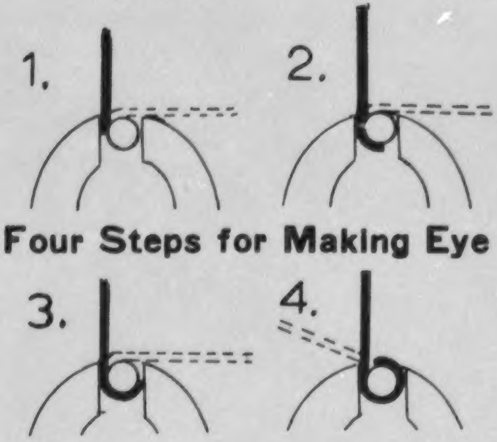
Use of Pipe to Start Bend



Starting Eye

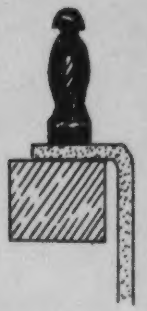


Starting Eye on Anvil Horn

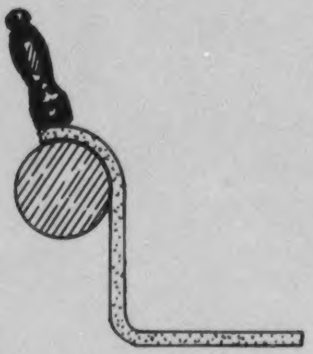


Four Steps for Making Eye

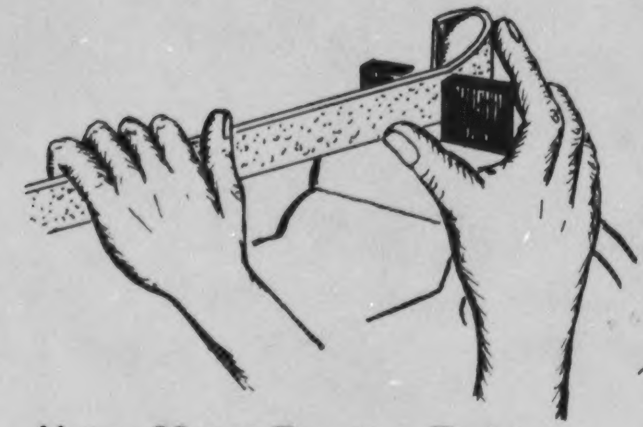
BENDING AND SHAPING METAL



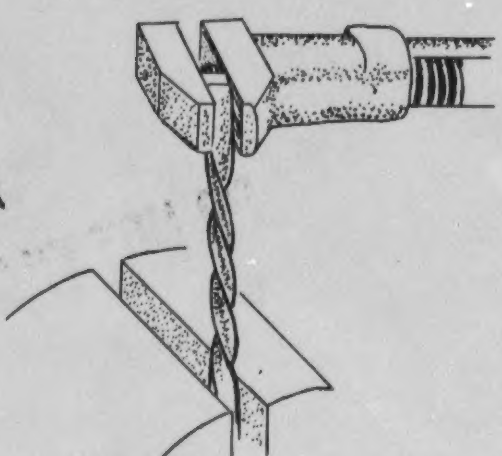
Ninety Degree Bend on Anvil



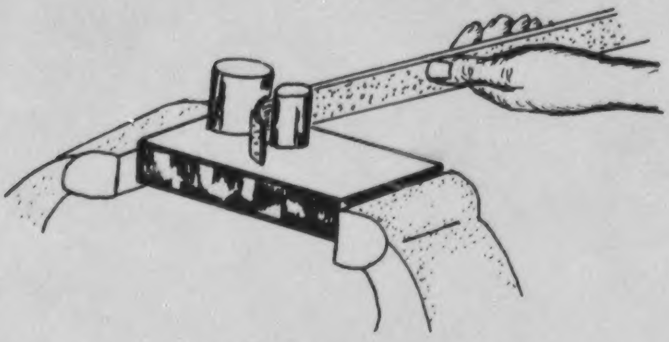
Shaping End on Anvil Horn



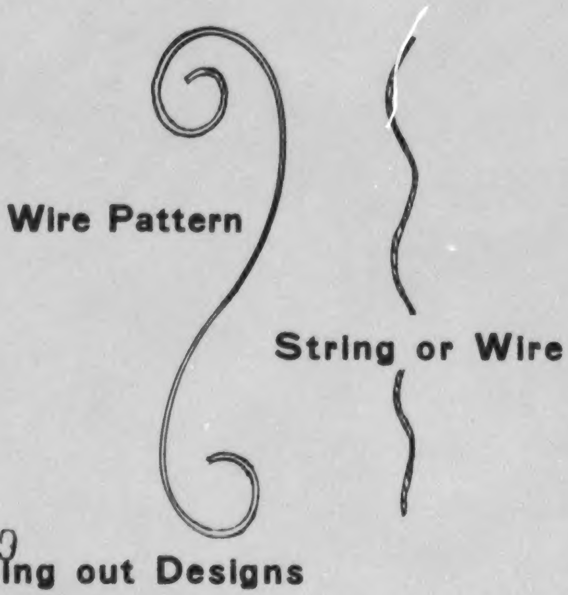
Using Metal Bending Fork



Twisting Square Rod



Using Jig to Bend Metal


Wire Pattern
String or Wire

Laying out Designs

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AGRICULTURAL MECHANICS

Unit C: Cold Metal Work

Topic 5: Drilling Holes

Suggested Procedure and Activities: The different types of hand drills and drill bits may be used as teaching aids during the class discussion.

1. The Importance of Drilling Holes, Types of Twist Drills to Use, Drill Parts, and Sizes of Twist Drills

   a. One of the most important tools in any metal shop is the drill. It is true that one of the most widely used methods of putting together metal is welding it; but bolts, screws, and rivets also play a very important part in farm machines construction and repair. Drilling holes in cold metal, therefore, is necessary in the machinery industry and in the farming operation.

   b. Listed below are four different types of hand drills used in cold metal work:

   Portable Electric Drill - Cold metal that is less than 1/2 inch thick can usually be drilled with ease by using a portable electric drill. The portable drill used for most cold metal work has a chuck that will accept a 1/2 inch or smaller straight shank twist drill. This type of drill can be mounted in a drill stand for the purpose of heavier and more accurate drilling.

   Hand Drill - The hand drill is usually used for drilling holes 1/4 inch or less. This drill is used for light metal work. Holes for small screws, bolts, and rivets can be drilled with this tool.

   Breast Drill - The breast drill is used to make holes in cold metal up to about 1/2 inch; that is, if the metal is soft and the twist drills are sharp. This drill can be used for about the same purpose as the portable electric drill.

   Post Drill - Post drills are used to drill large holes in metal. Due to the slow method of turning it by hand, the post drill will cut harder metal than other types of drills.

   c. Types of Drill Bits

   Flat - This bit has no flute. It is flat on both sides with two cutting edges. The bit will cut soft to medium hard metal.

Straight Fluted - This bit or drill has two straight flutes extending the length of the body. It will cut copper, brass, and other soft metal.

Twist - This drill is one of the most commonly used in metal work. The two-lip twist drill will cut different thicknesses of solid metal. Three- and four-lip twist drills are made to enlarge holes.

Transparency No. 1

d. Twist Drill Shanks and Parts

The types of shanks are:

Straight
Square or Bit-Brace
Bit stock
Taper or Morse
Blacksmith's
Ratchet

The parts of a twist drill include:

Shank - Top part held by chuck
Body - Part where grooves are cut
Flute - Grooves that run along the body
Tang - Flattened end of shank
Cutting lip - The cutting edge
Web - Metal in center with flutes on each side
Margin - Outer part of cutting edge
Point - Cone shaped cutting end

The principal parts are the shank, body, and point.

e. Identifying the Size of a Twist Drill

Fractional - This drill measurement is most commonly used in agriculture mechanical shops. Diameter of drill bits are determined by fractions of an inch. For example, they range in size from 1/64 of an inch and usually do not exceed one inch in diameter.

Alphabetical - The sizes of drills are also determined by letters A through Z. The letters actually are given in size in fractions of an inch which are measured by thousandths (.234" to .413").

Numerical - Alphabetical and numerical drills are often used by machinists. Drills #80 to #1 range in sizes from .0135" to .228". The #1 drill (.228") is a few thousandths smaller than 1/4 inch, and the #80 drill is a fraction larger than a human hair.

2. Determing an Effective Cutting Speed

a. The speed of a drill is calculated by determining how many feet the outer surface of a drill will travel per minute. If the standard cutting speed for a high carbon steel bit is 30 feet per minute while drilling mild steel, then the outside surface of the bit would travel 30 feet in the steel per minute. Thus, if the bit were laid on its side and rolled on the floor, it would cover a space of 30 feet.

Example: The circumference of a circle = the diameter multiplied by 3.1416. Drills are measured in terms of inches, therefore in order to change inches to feet the size of drill multiplied by 3.1416 (pi). divided by 12 equals the number of feet the drill will travel in one minute.

1/2 inch drill traveling at 229 revolutions per minute equals about 30 feet per minute.

$$\frac{1''}{2} \times \frac{3.1416}{12} \times 229 = \text{29.97 feet per minute or about 30 feet}$$

b. Recommended drill speeds for mild steel is as follows:

Diameter of Drill Inches	Revolutions per Minute	
	Carbon Steel (30 ft. per min.)	High-Speed Steel (60 ft. per min.)
1/16	1833	3667
1/8	917	1833
3/16	611	1222
1/4	458	917
5/16	367	733
3/8	306	611
7/16	262	524
1/2	229	458
5/8	183	367
3/4	153	306
7/8	131	262
1	115	229

High-speed twist drills should be used to cut harder metal than can be cut by carbon steel twist drills. High-speed drills are identified by a marking (HS or high-speed) on the shank. The carbon steel may not be identified by a marking on the bit.

3. Use of Cutting Lubricants for Different Metals

a. Oils are used to reduce the heat at the lips of the drill and float metal chips away while the cut is being made. If ordinary machine oil is used, it will interfere with the cutting by excessive lubrication; therefore, cutting oils should be used, espeically if a lot of drilling is done at one time. Excessive heat will draw the temper from the drill and soften it.

b. Special oils used on certain types of metals are listed below:

Wrought iron and malleable iron	Cutting oil
Hard steel or tool steel	Cutting oil
Brass or bronze	Cutting oil or dry
Cast iron	Dry
Copper	Milk, hard oil compounds or dry
Aluminum	Kerosene or lard oil compounds

Transparency No. 2

Lard oils are sometimes mixed with lubricating oils to form a cutting oil. Soluble and sulphurized-type oils are prepared as cutting oils for drilling holes and cutting metals.

4. Drilling a Hole in Cold Metal

a. Steps to observe when drilling cold metal include:

Use a scribe or scratch awl and mark a cross (+) on the metal at the center of the hole where the metal is to be drilled.

Dent the metal where the two lines cross by using a center punch. Check the dent to see if it is centered where the two lines cross, then hit the punch with a heavy blow to form a large dent for the drill.

Select the proper size and type of twist drill. It may be necessary to use a twist drill gauge to determine the exact size needed. The drill should be placed firmly in the drill chuck either by hand for a keyless chuck, or by the use of a key for a keyed chuck.

The work or stock to be drilled should be held firmly in a vise, held by a monkey wrench, or held by clamps.

Lubricate both the drill and hole while drilling. The type of lubricant to use depends upon the type of metal being drilled.

Apply steady pressure to the drill so that a smooth even cut is made as the bit passes through the metal. Hold back on the pressure as the point begins to pierce the underside of the stock.

To drill holes more easily, use a two drill method. Select a drill the size of the web of the large drill and make the first hole (pilot hole), the follow with the large drill.

Remove chips and shavings with a brush, blunt tool, or air when drilling a hole. If the flutes become clogged with either chips or shavings, the drill body may be twisted and broken. Steel produces shavings and cast iron produces chips during the drilling process.

b. Other things to observe when drilling holes in cold metal are as follows:

When using any type of hand drill the first precaution to observe is to hold the drill straight. Any leaning or side pressure may break the drill.

The stock must be firmly secured to prevent shifting while the hole is being drilled.

As the drill point passes through the metal, pressure must be lessened on the handle or handles.

Usually, the larger drill bit should turn slower than the smaller drill bit. Cutting lips can be dulled or burned if too much speed is used on certain hard metals.

If the speed is too slow, the drill bit will have a tendency to dig into the metal.

Drilling stocks should be placed in a position that will not permit springing. If the metal springs, the bit may break.

When drilling large holes, it may be necessary to drill a small pilot hole before drilling the large hole. Drilling is usually easier if a large twist drill follows a small hole; this is especially true when drilling hard metal.

Very thin metal can be drilled without bending it out of shape if it is clamped in a vise between two pieces of board while drilling the hole.

The drill press is a very important power tool for drilling thick or hard metal. Much more pressure can be applied by using a drill press than by using hand drills; therefore, it is used more than any other drilling tool. One of the limitations in using the drill press is its limited mobility. It cannot be moved and used in different places as can the hand drill.

References:

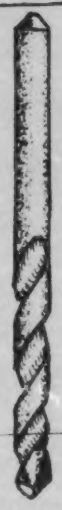
1. Ludwig, Oswald A. and Willard J. McCarthy, Metal Work Technology and Practice, McKnight and McKnight Publishing Company, Bloomington, IL, 1969.

2. Foss, Edward W., Construction and Maintenance for Farm and Home, John Wiley and Sons, Inc., New York, NY, 1960.

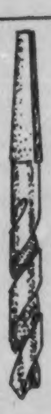
3. Wakeman, T. J. and Vernon Lee McCoy, The Farm Shop, The Macmillan Company, New York, NY, 1960.

4. "Farm Metal Work," University of Illinois, Urbana, IL.

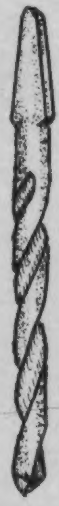
TWIST DRILL SHANKS AND PARTS



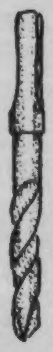
straight shank



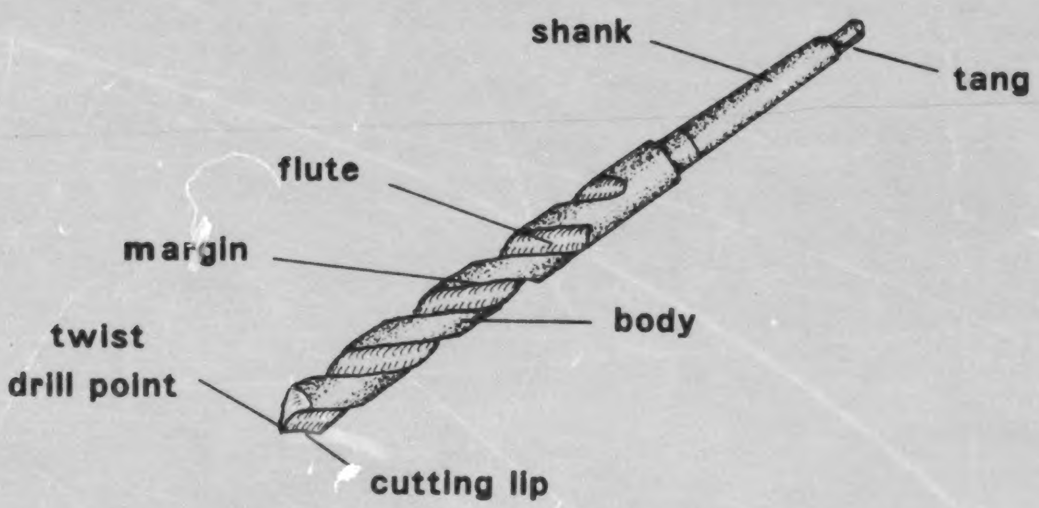
taller or morse shank



square shank

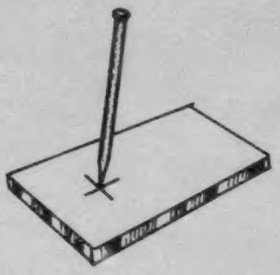


blacksmith's shank

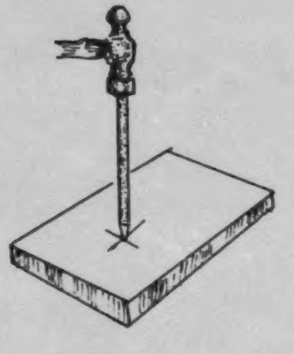

shank
tang
flute
margin
body
twist drill point
cutting lip

TWIST DRILL PARTS

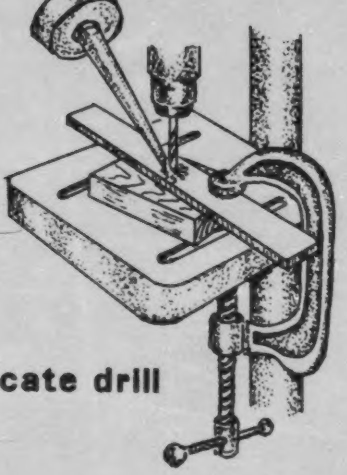
DRILLING A HOLE IN COLD METAL



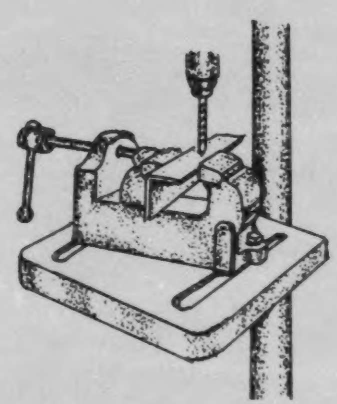
center by making a cross



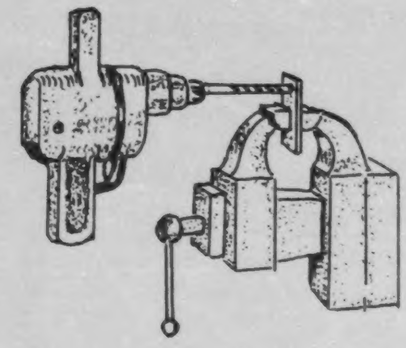
dent with center punch



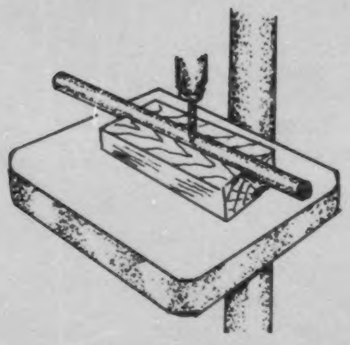
lubricate drill



vise for drill press



hold metal in machinist's vise when hand drilling



drill round metal with V-block

AGRICULTURAL MECHANICS

Unit C: Cold Metal Work

Topic 6: Tapping and Threading

Suggested Procedure and Activities: The transparencies may be used with the screw plate set during the class discussion.

1. The Importance of Threading and Tapping

   a. Many machines and other metal objects are assembled with bolts and nuts and rods. There are numerous agricultural mechanical projects that require the use of various sizes and types of bolts. Numerous farm structures and machinery are either braced or adjusted by metal rods. Cutting and reshaping threads is a common task around most shops.

   b. Water and gas pipes found in most building structures are made of wrought iron, usually galvanized. In order to fit pipe within a building or structure, it is necessary to cut and thread the pipe so that it can be joined with pipe fittings. Equipment used for threading pipe is different from equipment used for threading bolts. The pipe die cuts a tapered thread which makes a tight connection when screwed into a fitting. It is also heavier equipment than that used to thread rods and bolts.

   Transparency No. 1

2. Tools Required for Threading and Tapping

   a. Tools needed for threading include: dies of different sizes, die stock (handle), vise, file, and oil containers.

   b. Tools necessary for cutting threads in holes or in nuts are called taps, adjustable tap wrench, reamer or punch, file, and oil container.

3. Three Common Types of Threads

   a. USS or N.C. taps and dies are used for cutting United States Standard or National Coarse threads. (The term "USS" is becoming obsolete.)

   b. SAE or N.F. taps and dies are used to cut Society of Automotive Engineers or National Fine threads. (The term "SAE" is becoming obsolete.)

c. NPT taps and dies are used to cut National Pipe threads.

4. Purposes of the Tap and Die and Stocks (Handles)

a. Die - A die is a tool used to cut male (outside) threads on round-rod metal, so that it can receive nuts with the same thread or be screwed into a hole containing the same thread as the bolt or rod. The die is held in a die stock while being used. The die stock also holds the guide.

b. Tap - This tool is used for cutting threads inside a nut or inside a hole. The threads of the nut or hole must be of the same type as the bolt or rod that is to be used with it.

Transparency No. 2

5. Kinds of Taps and Dies

a. There are three kinds of taps used in making threads inside holes. They are:

Taper - The taper tap is used to make threads in holes that are drilled through the metal.

Plug - The plug tap is a very important tap in agricultural mechanics' shop. It is used to follow the taper tap in making threads in holes that are not drilled all the way through the metal.

Bottoming - The bottoming tap is not tapered at the bottom, and the threads are the same size from the top to bottom. It is used to follow the taper and plug tap in holes that do not pass through the metal.

b. The three kinds of dies are: the solid die, the round split die, and the two-piece die. The solid die cannot be adjusted. The split die can be expanded or made smaller by an adjustment screw on one side. The two-piece die has two thread-cutting jaws that can be adjusted in a round collet.

Transparency No. 3

6. Threading a Bolt or Rod

a. Threading a Bolt or Rod

Bevel the edge of the bolt by using a file or grinder.

Place the bolt in a vise to hold it firmly while threads are being cut.

Select a die of the proper size and place it over the bolt, guide first, and apply pressure as the turn is made clockwise.

After the first complete turn, apply a lubricant and thereafter apply the oil about every third turn. (When threading cast iron, oil should not be used.)

The die may be turned the desired length of the thread, except in the case of small diameter dies when the die flutes fill with loose metal and begin tearing the threads. The loose metal may be punched out of the flutes or the die may be turned back one-fourth turn each full turn. The backward movement breaks the chips that form on the forward turn.

Remove the majority of all chips from the flute before removing the die from the bolt.

If the bolt is being cut for a particular nut, try screwing it on a bolt of the same size in diameter and the same type of threads being cut or cut a few threads and try the nut on the bolt.

Hardened steel rod should not be threaded with a die. The die must be harder than the metal it is to cut.

b. Tapping a Hole

Select a twist drill for the proper size of hole to be threaded. The size of a drill is usually determined by a chart or by using the second visible thread on a taper tap. A hole that is too large will give imcomplete threads. A hole that is too small will cause too much pressure to be put on the tap.

Secure the stock or nut being tapped so that it will not move from the tapping position.

A downward pressure should be applied on the tap at the same time it is turned in the hole. After the tap begins to take hold of the metal, the pressure is released.

Apply a lubricating oil to the tap operation as applied in the die operation.

The flutes of a tap can be kept clean in most cases if a one-fourth counter-clockwise turn is made after each full turn.

Clean the tap flute before removing it from the hole.

7. General Information for Tapping and Threading

a. Coarse (NC) threads are used on braces, bolts, and adjustment rods in farm machinery. Fine (NF) threads are used on tractors, cars, and trucks.

b. Agricultural mechanics shops may select a tap and die set (screw plate) that will cut NF and NC threads. A screw plate set that will cut 1/8 inch standard pipe threads, 4-36, 6-32, 10-24, and 12-14, machine-screw threads, and NF and NC threads from 1/4 inch to 3/4 inch will meet the needs of most shops. 4-36 is a number four screw with 36 threads per inch.

c. The tap sizes and twist drill sizes for bolt threads are listed below:

Size of Tap	Size of Tap-Drill (NC)	Size of Tap-Drill (NF)
1/4"	3/16"	7/32"
5/16"	1/4"	1/4"
3/8"	5/16"	5/16"
7/16"	11/32"	25/64"
1/2"	13/32"	29/64"
9/16"	15/32"	33/64"
5/8"	17/32"	37/64
3/4"	21/32"	11/16"
1"	7/8"	15/16"

d. Rethreading is necessary when the threads are marred on a bolt. The same type and size of die is used to correct the threads as those used to make the original threads. The use of the die is the same for threading and rethreading a bolt.

e. The following precautions should be observed while using the screw plate set.

If a tap breaks in the metal, it may be advisable to grind it level with the surface and leave it in the metal. Taps are made of a very hard metal and usually cannot be removed by drilling.

Due to the hardness of the metal in taps and dies, the small sizes are very easily broken. Also, small taps must be held completely straight while tapping a hole. Taps may be burned due to over-heating when entering a hole.

The bolt, rod, nut, or stock must be held in a vise or other methods can be used in such a way that all movements will be eliminated while threads are being cut. Usually bolts, rods, and holes are threaded in a vertical position.

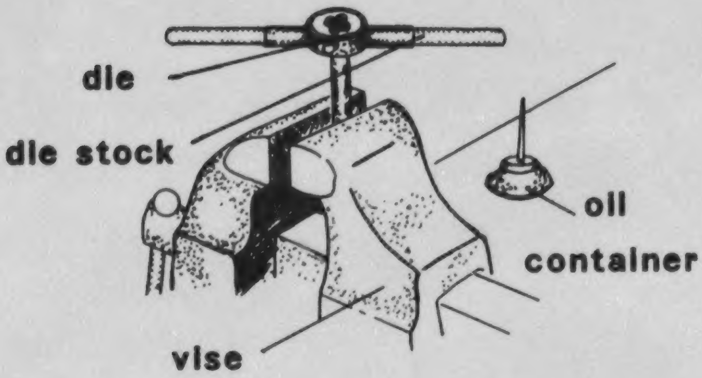
References:

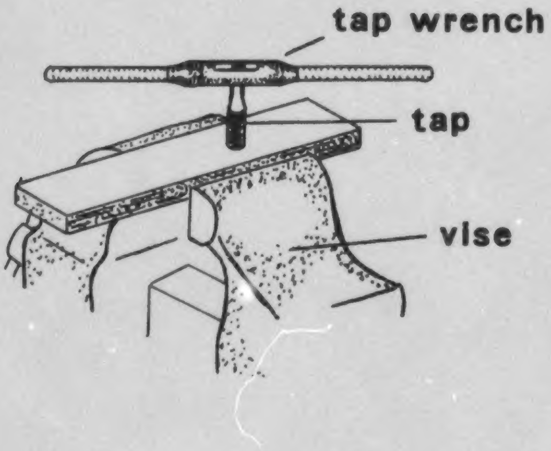
1. Foss, Edward, W., Construction and Maintenance for Farm and Home, John Wiley and Sons., Inc., New York, NY, 1960.

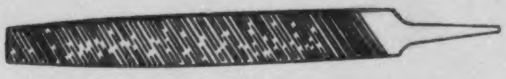
2. Ludwig, Oswald A. and Willard J. McCarthy, Metalwork Technology and Practice, McKnight and McKnight Publishing Company, Bloomington, IL, 1969.

3. Wakeman, T. J. and Vernon Lee McCoy, The Farm Shop, The Macmillan Company, New York, NY, 1960.

TOOLS FOR THREADING AND TAPPING


die
die stock
oil container
vise


tap wrench
tap
vise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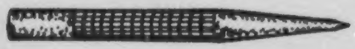
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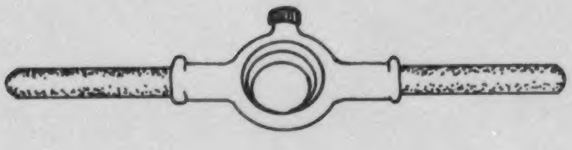
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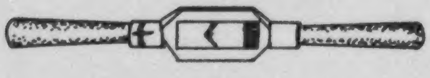
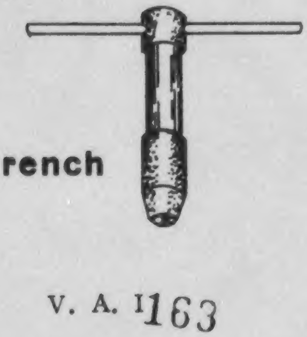
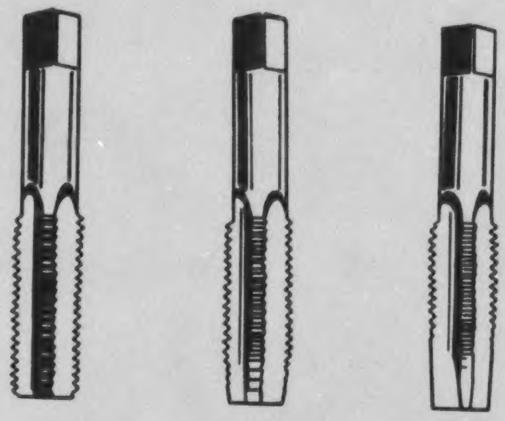
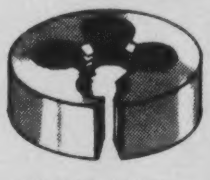
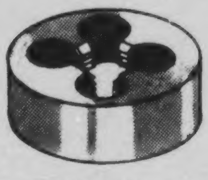

tap wrench


T-tap wrench

TAPS


BOTTOMING TAP
PLUG TAP
TAPER TAP


SPLIT DIE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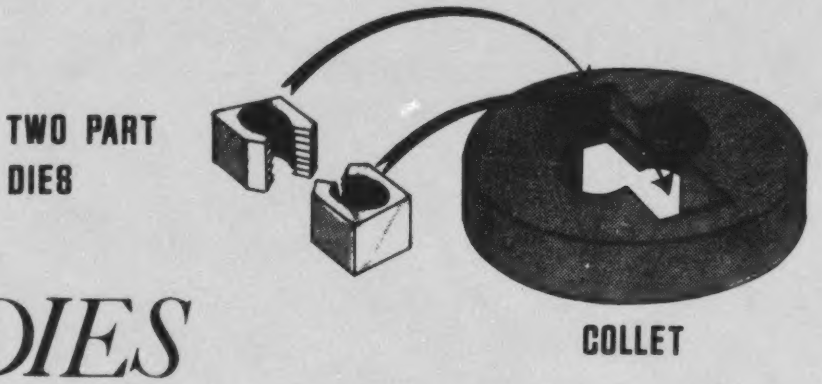
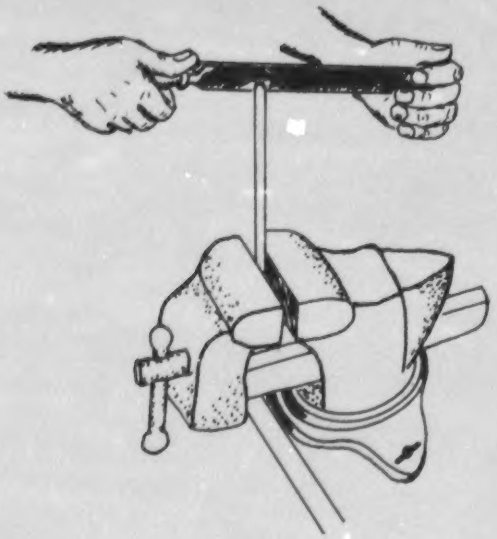
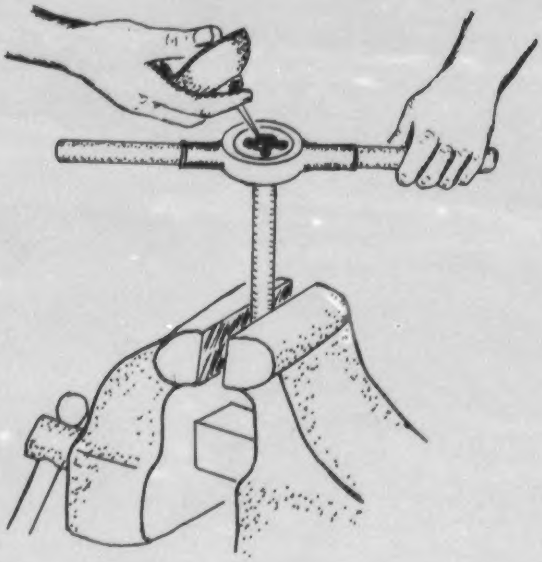

TWO PART
DIES
COLLET

DIES

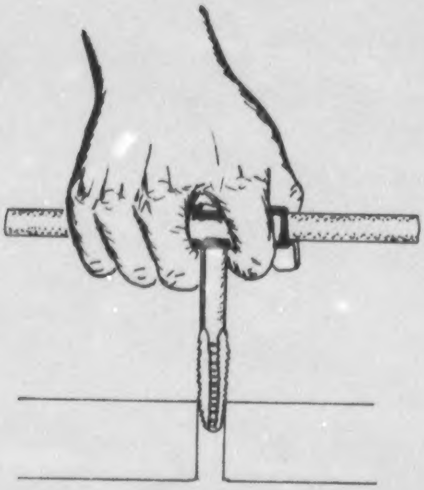
THREADING AND TAPPING



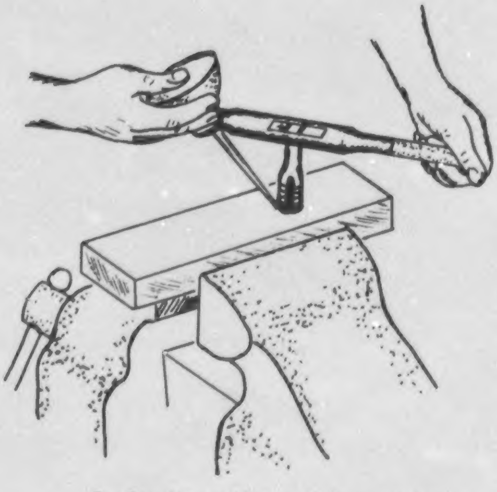
beveling the edge



lubricating the die



tapping a hole
starting tap straight



lubricating the tap

Vocational Instructional Services
Agricultural Education

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Basic V.A. I
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AGRICULTURAL MECHANICS

Unit C: Cold Metal Work

Topic 7: Bolting and Riveting

Suggested Procedure and Activities: Different kinds of bolts and rivets may be used as teaching aids during the class discussion.

1. The Importance of Bolts in Agricultural Mechanics

a. The major purpose of using bolts is to fasten metal to metal or to fasten other types of materials with metal.

b. Bolts are used for the following reasons:

Where it is necessary to dismantle a metal structure.

To give strength or permanency to a metal object.

To fasten covers that conceal engine or motor parts that may need repairing occasionally.

To make adjustments on machinery so that the machine will operate properly.

To reduce the cost of cutting and welding for large repair jobs.

Transparency No. 1

2. How Bolts are Used to Join Metals and Other Materials

a. Bolts can be passed through unthreaded holes or into threaded holes for joining metals together. If the piece of metal is to be disassembled frequently, machine bolts should be used in the place of carriage bolts, that is, if the bolt head does not create a problem. The head of this bolt can be held with a wrench when tightening or loosening the nut.

b. Stud bolts (bolts without a head and threaded on each end) are usually used for special purposes. One end of the stud bolt has a nut screwed on it after the other end is screwed into a hole. Stud bolts are seldom used in holes that are unthreaded. If they are used under these conditions, the bolt requires a nut on each of its threaded ends.

c. Carriage bolts are usually used to join metal to wood, but they can be used to join metal to metal. This oval head bolt has a square shank that sinks into the wood to keep the bolt from turning while the nut is being removed. Some metal holes are cut square to receive the shank of a carriage bolt. This bolt is used more successfully in hardwood construction.

d. Machine screws are used in a similar way as the different types of bolts except they are purchased without nuts. Therefore, if they are used in threadless holes, it is necessary to find nuts for the screws. Cap screws are also used to fasten two pieces of metal together, but they are screwed into threaded holes. Stove bolts are used to join metal together. They are threaded the entire length of the bolt.

Transparency No. 1

3. Bolt Threads

Bolt threads are classified as Unified (National) Coarse (UNC), or Unified (National) Fine (UNF). Threads on different kinds of bolts are:

Machine - UNC and UNF
Carriage - UNC
Stud - UNC and UNF
Machine Screws - UNC and UNF
Stove Bolts - UNC
Cap Screws - UNC and UNF

Transparency No. 2

4. Common Types of Washers Used with Bolts for Joining Metal to Metal or Joining Metal to Other Materials

a. Flat or cut washers are used to protect the metal or other material from the bolt head or nut. They also give the bolt head and nut more supporting surface.

B. Lock washers are normally used between the metal surface and nut to prevent the nut from backing off the bolt. They form a tension between the nut and the material to eliminate nut and bolt movement.

Transparency No. 1

5. Kinds of Heads Found on Machine Screws, Cap Screws, and Bolts

a. Machine screw heads are slotted for screw-driver use. The heads are round, oval, fillister, and flat.

b. Cap screw heads are slotted for common and Phillips screwdrivers, hexagon-shaped, socket (holes within head for special wrench use), and fillister. The heads are made flat, oval, or round.

6. Joining Metals Together or Joining Metal with Other Materials

a. The top piece of metal is center punched at the point where the metal is marked (+) with a scratch awl.

b. The proper size twist drill is selected to make a hole for the bolt. If the hole is too small, a long tapered reamer may be used to enlarge it.

c. The two ways to drill holes in metal that is to be joined together are:

Clamp one or more pieces of metal together and drill all aligned bolt holes at the same time.

Mark the two pieces of metal separately and drill the holes separately; then place a bolt in the two drilled holes and drill the reaming holes.

d. Nuts are usually drawn tightly when bolting metal together. Proper pressure on a nut will not damage the threads or lengthen the bolt. A bolt may be stretched by applying too much pressure on the head or nut, or it may be twisted into the hole. Most machinery nuts require a given amount of pressure applied by torque wrenches. Many nuts of this type (castle) are held in place by cotter pins.

e. Bolts on vibrating machinery are secured by lock washers under the nut. When metal is attached to wood, flat washers may be used between the bolt head or nut and the wood surface. A wing nut is used where tightening pressure can be accomplished by the thumb and finger. Lock washers are usually not used with wing nuts.

f. It is very important that the proper size and type of wrench be used on bolt heads and nuts. For example, adjustable wrenches are considered good square nut wrenches. A socket or box-end wrench is usually considered best for use on hexagon head bolts and nuts. Open-end wrenches are used on either the square head or hexagon head. Pipe wrenches should be used on pipe or round rods. Wrenches with ratchet handles are used where a large number of bolt work is done.

7. Purpose of Riveting Metal

a. Rivets are used to join or hold metal parts in a permanent position.

b. Riveting metals together is a convenient way to repair farm machinery and equipment, if both pieces of metal are not too thick.

8. Self-Tapping Screws

a. As a self-tapping screw is driven into a hole, it cuts threads on the stock. This type of screw is used on sheet metal, soft steel, plastic, asbestos, and plywood.

The head styles are similar to the common screws and bolts. Tapping screw ends are tapered so that they will enter the hole easily and the thread will begin cutting threads in the stock.

Some of the many head styles are:

Slotted
Frearson Recess
One-Way
Phillips Recess
Clutch Recess
Hex Head

b. Tapping screws are installed by locating the place for a hole and then prick punching the location. Drill the hole by using a drill slightly larger than the root diameter of the tapping screw. Most machinist handbooks list the sizes of drills for various sizes of holes. The size of drill may be determined by placing the drill behind the screw point or root.

Transparency No. 3

9. Rivet Head Types and Rivet Sizes Most Commonly Used

a. Rivet head types include:

Button
Cone
Tinner's
Flat
Truss
Pan
Round top countersunk
Flat top countersunk

b. Rivets of 1/8, 3/16, 1/4, 5/16, and 3/8 inches are commonly used sizes for farm machinery and equipment.

Transparency No. 4

10. Riveting Metal

a. Mark (+) the centers of rivet holes on the metal and center punch each hole.

b. Use a twist drill the size of the rivet to make the hole.

c. Countersink the holes if countersunk rivets are to be used.

d. If the rivet is too long, cut it 1/16 inch to 1/8 inch above the metal surface. This short projection is flattened to form a rivet head. If a rivet set is used, the part projecting above the metal should be 1-1/3 times the diameter of the rivet.

e. Before the rivet is cut, it may be drawn against the metal by inserting the rivet set hole and tapping the set with a hammer.

f. When heading a rivet, the first few hammer blows should be made straight down on the rivet; then the rivet set should be used to form the head.

References:

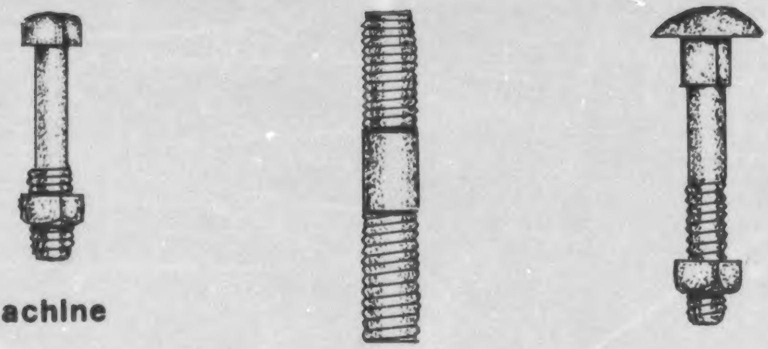
1. Foss, Edward W., Construction and Maintenance for Farm and Home, John Wiley and Sons, Inc., New York, NY, 1960

2. Ludwig, Oswald A. and Willard J. McCarthy, Metalwork Technology and Practice, McKnight and McKnight Publishing Company, Bloomington, IL, 1969.

3. Phipps, J. Floyd, Mechanics in Agriculture, The Interstate Printers and Publishers, Inc., Danville, IL, 1967.

4. Wakeman, T. J. and Vernon Lee McCoy, The Farm Shop, The Macmillan Company, New York, NY, 1960.

BOLTING IN METAL WORK

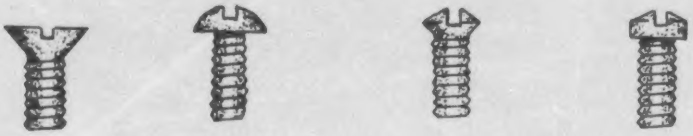


machine

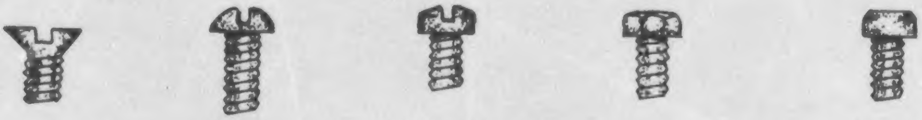
stud

carriage

BOLTS



MACHINE SCREWS



flat

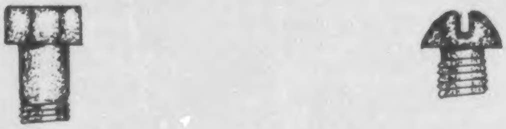
round

fillister

hexagon

socket

TAPPING SCREWS

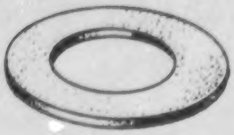


national fine (UNF)threads

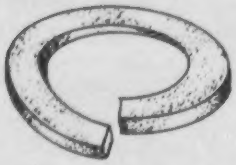
national coarse (UNC) threads

CAP SCREWS

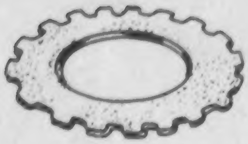
WASHERS AND NUTS



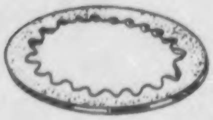
flat washer



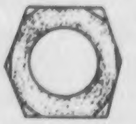
helical spring type washer



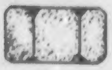
external lock washer



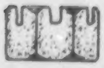
internal lock washer



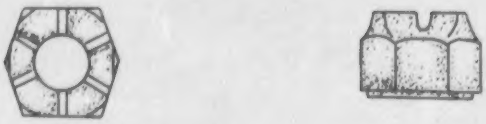
hex nut



hex nut

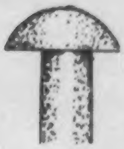


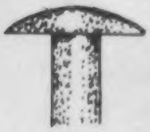
double chambered hex nut

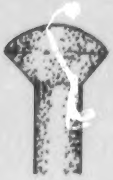


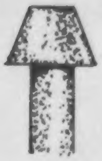
washer faced (WF) hex nut

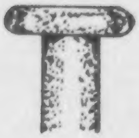
RIVET HEADS

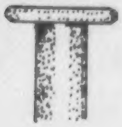

truss

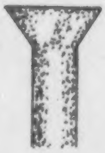

button

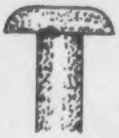

countersunk
round top


cone

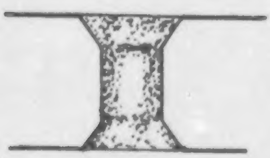

flat

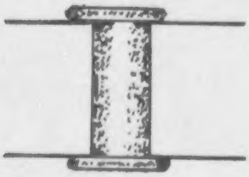

tinner's

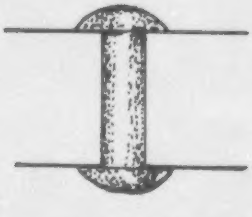

countersunk
flat top

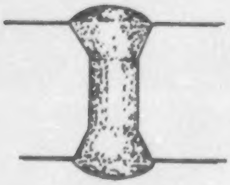

pan

RIVETS SET

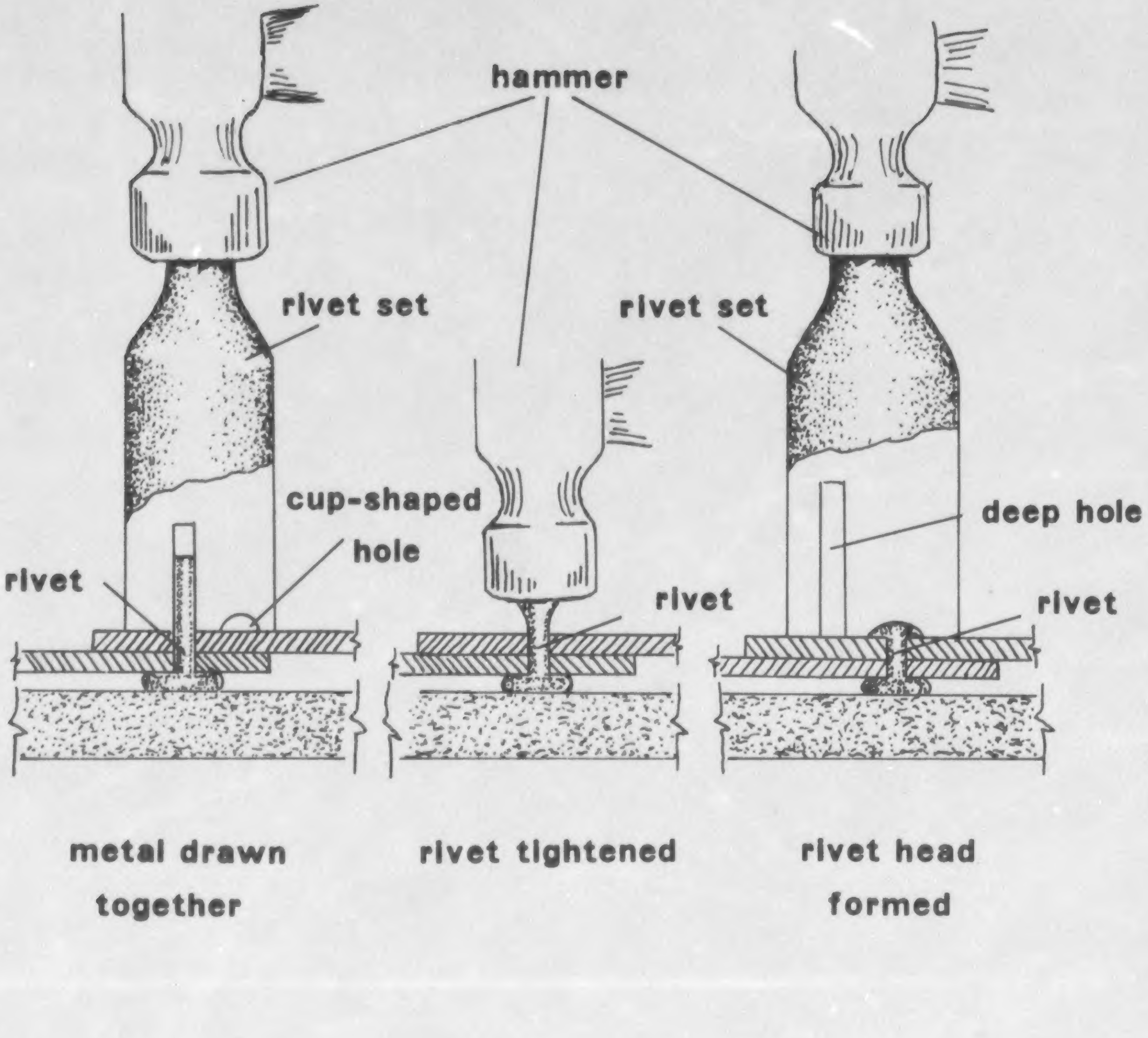

countersunk
with hammer


flat head
with hammer


round head
with hammer


countersunk
with round top

SETTING A RIVET


hammer
rivet set
rivet set
cup-shaped
hole
rivet
rivet
deep hole
rivet

metal drawn together

rivet tightened

rivet head formed

AGRICULTURAL MECHANICS

Unit C: Cold Metal Work

Topic 8: Removing Broken Bolts

Suggested Procedures and Activities: A sample of extracted bolts can be used as a teaching aid during the class discussion.

1. Why Broken Bolts Create a Problem -- Equipment Necessary to Remove Broken Bolts

   a. Many agricultural mechanics shops are not supplied with the various types and sizes of bolt extracting equipment that is necessary to remove any kind and size of bolt. Most bolts break at the surface of the hole, thus eliminating the use of any type of pliers or wrenches to extract the part left in the hole.

   b. Equipment that may be used to remove bolts is as follows:

      Hand drill and drill bits
      Standard cold chisel, diamond point and round-nose chisels
      Ball peen or blacksmith's hammer
      Starting, center, and peen punches
      Adjustable and tap wrenches
      Hacksaw and screwdrivers

   Transparency No. 1

2. Methods Used to Remove Broken Bolts

   a. Screwdriver - Steps in using the screwdriver are:

      Saw a slot across the broken bolt or cut a slot in the end with a cold chisel. It may be necessary to cut into the base metal to make the slot deep enough for a screwdriver.

      A screwdriver is used to back the broken bolt out of the hole.

   b. Punch and Chisel - If the screwdriver fails to break the bolt loose, a round nose punch or a flat chisel can be used by placing either the punch or chisel on one side of the end of the stud (bolt) and tapping lightly.

c. Screw Extractor - If the bolt is too tight to be backed out of the hole with a punch, then it may be necessary to use an extractor. The steps to follow are:

Dent the center of the broken bolt with a center punch.

Drill a pilot hole into the center of the stud, then follow the pilot drill with the size of drill that is found on the shank of the screw extractor.

Use the proper size screw extractor with a center punch.

Apply pressure to force the fluted end of the extractor in the hole and then turn it counter-clockwise.

d. Other Methods - Other ways to extract broken bolts are:

A hole is drilled in the stud (broken bolt) in the same way as drilling a hole to insert a screw extractor, except that the hole may be larger in diameter and deeper. A diamond point chisel is tapped lightly into the hole and the stud is backed out by using an adjustable wrench on the chisel body.

A large hole is drilled in the stud by following the steps for drilling a hole to accommodate a screw extractor. The stud wall is left thin so that it may be pushed in with a chisel or punch. A flat instrument (screwdriver, etc) may be used to force the stud out by turning it.

The broken bolt may be drilled completely out and the hole retapped for a larger bolt. If the broken bolt is large (over 1/2 an inch) the hole may be drilled with three different sizes of drills including the pilot twist drill, in order to make the drilling easier.

Heat causes metal to expand and cold causes it to shrink. Heat also causes rust and other foreign materials to break loose from the metal. After a broken bolt is heated and cooled it may be easier to remove with a screwdriver, punch, chisel, or extractor.

3. Sizes of Drills and Extractors to Use

Twist Drill Inches	Size of Bolt Inches	Extractor Size No.
5/64	3/16 - 1/4	1
7/64	1/4 - 5/16	2
5/32	5/16 - 7/16	3
1/4	7/16 - 9/16	4
1-1/16	1-3/8 - 1-3/4	8
1-3/16	1-3/4 - 2-1/8	9
1-5/16	2-1/8 - 2-1/2	10
1-9/16	2-1/2 - 3	11

4. General

   a. Broken bolts may be removed by welding nuts on them and backing them out with a wrench.

   b. The use of penetrating oil may aid the extraction of broken studs, especially if the studs are rusty.

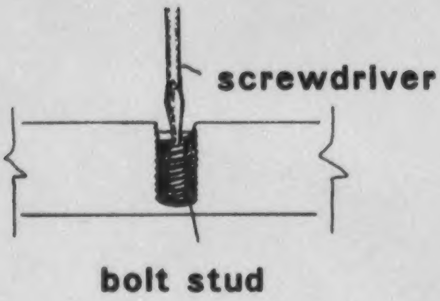
   c. If the threads inside a hole have been damaged, it may be necessary to retap the hole before using it.

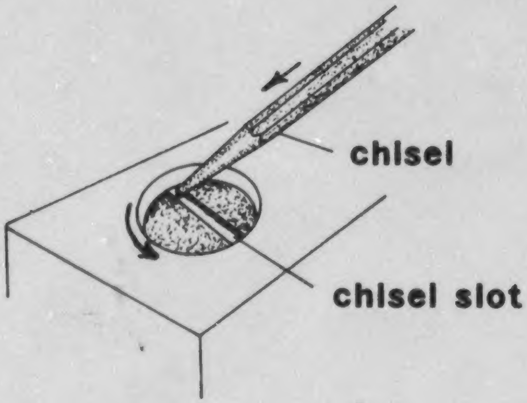
   d. Screw extractors are easily broken if too much pressure is applied while backing out a broken stud. If an extractor breaks, it may be necessary to remove it with a cold chisel or punch by breaking it into small pieces.

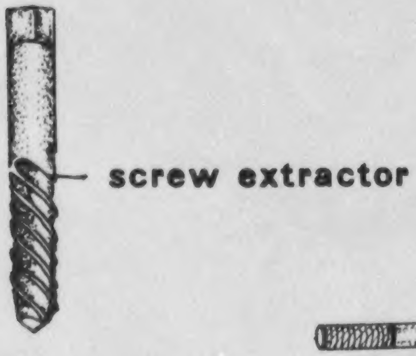
References:

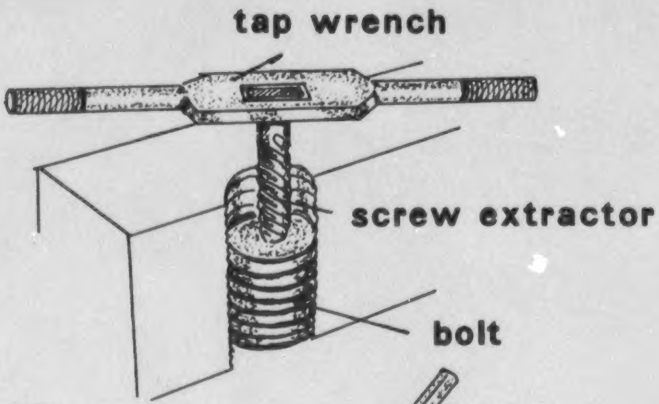
1. Ludwig, Oswald A. and Willard J. McCarthy, Metalwork Technology and Practice, McKnight and McKnight Publishing Co., Bloomington, IL, 1969.
2. Phipps, Floyd J., Mechanics in Agriculture, The Interstate Printers and Publishers, Inc., Danville, IL, 1967.
3. "Farm Metal Work", University of Illinois, Urbana, IL.

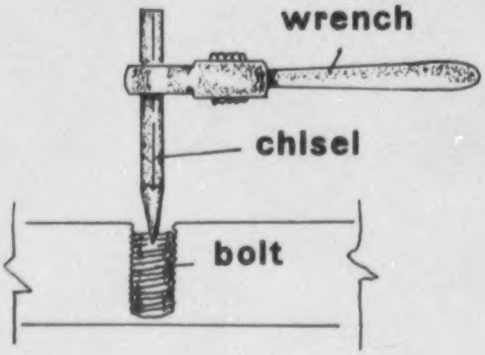
REMOVING BROKEN BOLTS

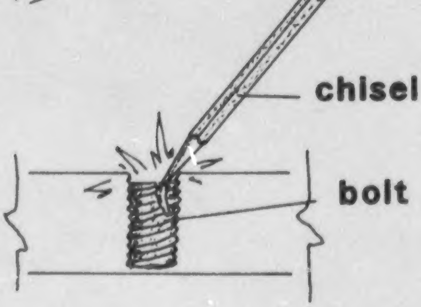

screwdriver
bolt stud


chisel
chisel slot


screw extractor


tap wrench
screw extractor
bolt


wrench
chisel
bolt


chisel
bolt

AGRICULTURAL MECHANICS

Unit D: Selecting and Applying Paint

Topic 1: Brush Painting

Suggested Procedure and Activities: Labels from old paint containers, types of brushes, and samples of paint failures may be used as teaching aids.

1. Why It Is Important to Have a Knowledge of Painting

a. Painting is important because:

Paint may protect metal, wood, and masonry surfaces either from corrosion, decay, or wear.

The value of equipment and property may be partially maintained by a routine painting program.

When a good painting program is followed the cost of maintaining is reduced.

Paint may add to the appearance of buildings, equipment, and articles.

b. It is important to select the proper paint for the following reasons:

Good grades of paint contain the correct amount of ingredients. For example, a good paint contains 60% pigment, and up to 40% vehicle. Enamels contain 60% vehicle and 40% pigment. In areas where hydrogen fumes and mildew are a problem, the pigment should contain between 18 and 40% zinc oxide.

About two-thirds the cost of painting is in the labor; therefore, one-coat paint is widely used on wood.

Dead pigments such as chalk, talc, and barium sulphate may discolor the brick on a house. Good paints contain no more than 20% of dead pigment.

There are many kinds of paint made for either wood, metal, or concrete. It may not be advisable to use a metal paint on wood.

Some surfaces must be cleaned with a solvent or soap and water occasionally; therefore, a paint must be selected that will withstand cleaning.

c. Types of Paint

Enamel - This paint is used mainly for inside woodwork. It contains a varnish instead of a drying oil.

Rubber-Base - Rubber-base paints have taken the place of many interior oil paints. Synthetic rubber is emulsified in such a way that it mixes with water. It may be brushed on a surface or rolled on.

Outside Paint - Exterior paint usually has an oil vehicle (liquid part of paint), which is either raw or boiled linseed oil. The pigment may be titanium dioxide, white or red lead, zinc oxide, or iron oxide.

White lead pigment is used in exterior paint.
Red lead pigment is one of the best metal primers.
Zinc oxide causes the paint to be mildew resistant.
Iron oxide is considered one of the most durable outside pigments.

Aluminum - This paint is used on metal after a coat of red lead or blue lead paint has been used. It is made of aluminum powder and spar varnish. It will stop the bleeding through of lead paints or creosote.

Cement - Cement water paints are used to prevent moisture entering masonry walls. Usually the paint is brushed into the surface where it forms a hard protective film over the masonry.

Other Paints - Several other important paints include:

Varnish - Varnish is made of gums, resins, and oils. It can be found for either exterior or interior use.

Shellac - This paint is made of gum and alcohol. It is mainly used on wood finish to preserve the paint beneath it.

Metallic Zinc - This paint is used on metals to prevent rust. Two coats will last more than 10 years.

Casein - Casein paint forms a hard film on interior surfaces, and it can be washed.

Calcimine - This paint is used for interior painting. It cannot be washed. Calcimine is spread on walls with a large brush or roller.

It is important that labels be studied on paint containers to determine paint composition. For example, a maximum for extenders (ingredients with little hiding power and film durability) should be 10% or less.

The most common extenders are silica, calcium carbonate, and magnesium silicate. Low grade paint lacks the following:

Lasting power or durability
Ability to cover the surface
Quality to prevent cracking, chalking, peeling, and alligatoring
White lead to take the place of low grade fillers

2. How to Prepare the Surface

a. New Surface - New surfaces usually require less time to prepare than old ones. Steps in preparing wood and metal surfaces include:

Smooth the surface if necessary.

Wipe the surface clean of all dust, moisture, grease, and other matter that may interfere with a good paint job.

Use a good rust inhibiting primer for metals.

Use a good crack or hole filler for wood surfaces.

b. Old Surfaces - Old surfaces are more difficult to prepare than new surfaces.

Steps in preparing an old surface are:

Use a mild caustic compound with steam or hot water to clean farm machinery. Kerosene and other cleaning solvents can be used if steam is not available. Compressed air, a putty knife, wire brush, emery cloth, and a screwdriver are necessary items to remove paint from metal.

If bolts are present, they should be tightened before paint is applied.

All repair work should be completed on farm machinery before it is painted.

Using a blow torch or a good liquid paint remover is the easiest way to clean farm machinery of old paint. This practice will require scraping the old paint off, sanding the surface, and applying a priming coat.

Steps in preparing painted wood are:

All repair work should be accomplished before repainting is started.

The painted surface can be prepared for repainting by cleaning it with a solvent saturated cloth, brushing, washing, and sanding. All loose or cracked paint, putty, wood filler, oil, dust, and undesirable matter should be removed.

All cracks are areas that need filling should be filled with putty or a wood-filler.

Any loose screws or bolts in the wood objects should be tightened.

Transparency No. 1

3. Problems Encountered in Applying Paint

a. Paint Failures - There are six major causes for the failure of paint to give long protective coating. The causes are:

Blistering and Peeling - Blistering is caused by moisture collecting behind the paint, or moisture in the wood or on the surface at the time of painting. Almost all painting is done where the surface is dry.

Cracking and Scalding - Cracking is caused by the surface expanding and contracting. A high grade of paint will have a more elastic effect to prevent this paint failure.

Running and Sagging - Paint applied too thickly or a paint containing too much oil will run or sag. Also, a glossy surface may cause paint to sag. A glossy surface should be sandpapered before it is painted.

Wrinkling - Wrinkling is a common cause of paint failure. If the surface dries before the paint underneath dries, it will wrinkle. A drop in temperature, thick coat, or too much oil are some of the main causes of wrinkling. Wrinkles should be sanded out before repainting.

Checking- This failure in painting is the result of not mixing the proper proportions of thinner and oil and failing to allow paint to dry between coats. The fine hairlines that appear in checking are only in the outer coat.

Chalking - Surface that has been painted for a long period of time may have a tendency to chalk. The pigment will stick to anything it touches. Low grade paints chalk more easily than high grade paints.

b. How to Determine the Amount of Paint Needed - The amount of paint needed is estimated as follows:

The amount of paint required to cover a surface depends upon whether or not the surface is smooth or rough, the skill of the painter, and the type of material used to make up the surface. High grade paints may cover over 500 square feet for the first coat and over 600 for the succeeding coats.

The approximate area a gallon of paint will cover is estimated as follows:

Height x length of surface to be painted.

"Height with gable" is gable height x half the gable width.

Include the window and door areas. It takes more paint to paint around the openings.

Divide the total square feet by the recommended coverage listed on the paint label. For example:

A building 30 feet long, 10 feet high, 25 feet wide, and 1 gable 6 feet high has a total outside area of 1250 square feet.
2 x 30' = 60' (sides)
2 x 25' = 50' (width)
10 x 110' = 1100 square feet around building
6' x 12-1/2 (1/2 gable width) = 75 feet square one gable end
2 x 75 = 150 square feet for both ends
150 square feet + 110 square feet = 1250 square feet

$$\frac{1250 \text{ sq. ft.}}{500 \text{ sq. ft. per gal.}} = 2\text{-}1/2 \text{ gallons to paint the building}$$

c. Equipment and supplies needed are:

Paintbrushes - 1 inch for small trim, 1-1/2 to 2 inch for average type trim, and 3-1/2 to 4 inches for other larger surfaces. The best brushes are made of 100% hog bristles.
Paint scraper
Wire brush
Putty knife
Hammer, nail set, and wrenches
Mixing bucket and paddle
Ladders
Putty and wood filler
Sandpaper, emery cloth, and rags
Thinner and solvents for cleaning

d. Paint is mixed by pouring the thin material off the pigment, stirring the pigment with a paddle, adding the thin material to pigment, and continuing to stir until the paint is mixed.

4. Steps to Follow When Applying Paint

a. Hold the paint brush by placing the thumb over the small part of the brush handle with the fingers resting on the brush ferrule (large part of brush).

b. Dip about one-third the length of the bristles into the paint.

c. Remove the excess paint from the brush by wiping one side against the paint bucket.

d. Apply paint to a surface by bringing the brush against it very lightly, then make long sweeping strokes in the same direction to form a thin uniform film. The brush should be lifted gradually at both ends of the stroke to form a thin film.

5. Important Things to Observe in Painting

a. Paint during dry seasons when the temperature is about 65 degrees.

b. There are several grades of paint. Due to its lasting effect and cost of applying, the best grade is usually the cheapest.

c. While painting rough surfaces use the brush in several directions to force paint into the wood.

d. If the paint brush is used for more than a day, it may be immersed in linseed oil or paint thinner. At the end of a painting job the brush should be washed several times in kerosene or paint thinner, then washed in soap and water. A brush used in water-thinned paints should be washed daily with soap and water. The shape of brush bristles can be maintained by wrapping them in paper after they have been washed.

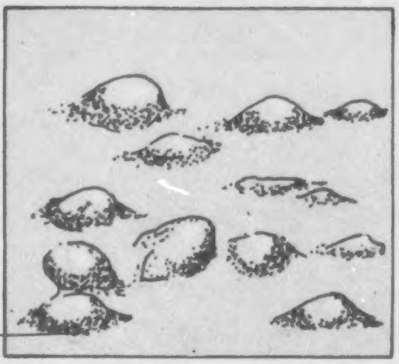
References:

1. Foss, Edward W., Construction and Maintenance for Farm and Home, John Wiley and Sons, Inc., New York, NY, 1960.

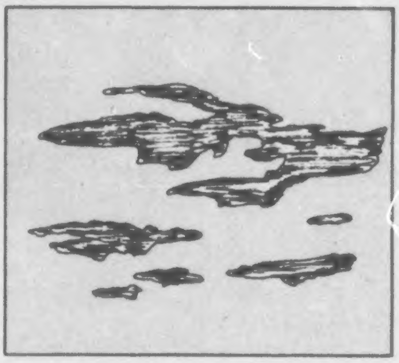
2. Phipps, Lloyd J., Mechanics in Agriculture, The Interstate Printers and Publishers, Inc., Danville, IL, 1967.

3. Wakeman, T. J. and Vernon Lee McCoy, The Farm Shop, The Macmillan Company, New York, NY, 1960.

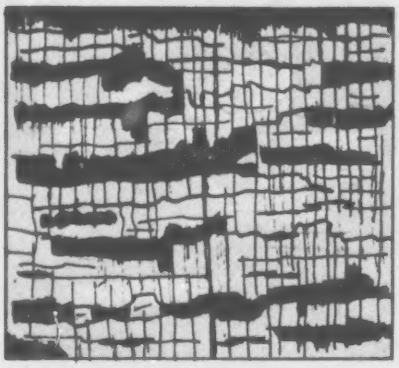
PAINT FAILURES



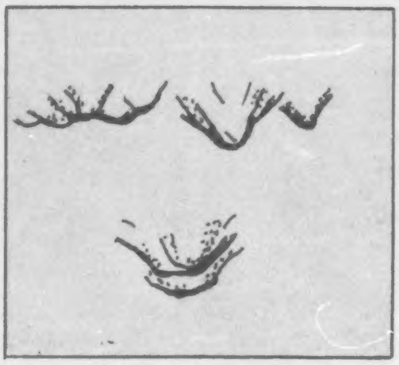
blistering



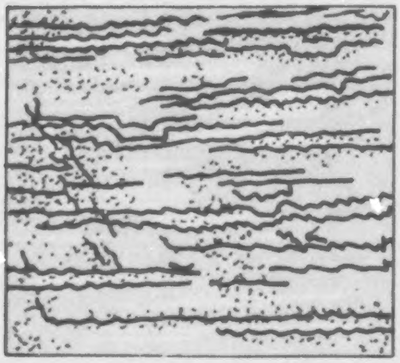
peeling



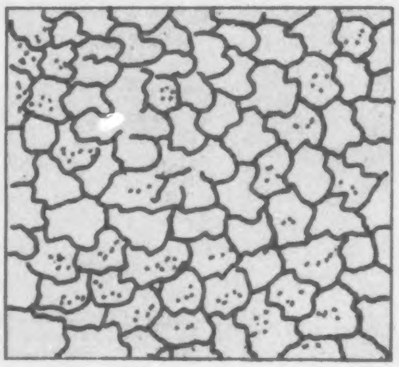
cracking & scaling



running and sagging



wrinkling



cracking & alligatoring

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V-D-2
Basic V. A. I
Agdex 016 x 700
784

AGRICULTURAL MECHANICS

Unit D: Selecting and Applying Paint

Topic 2: Spray Gun Painting

Suggested Procedure and Activities: During the class discussion a spray gun, paint cup, and pressure tank may be used as teaching aids. Also the transparencies may be helpful.

1. Why Spray Painting is Economically Important

a. A mechanical means of applying paint is used by manufacturers who make farm machinery, trucks, automobiles, tractors, furniture, toys, shoes, appliances, and many other types of equipment found around the home and farm. Spray painting is similar to brush painting in that it improves the appearance and life of an item, thus making it more valuable.

b. There is little comparison in the cost of spray painting and brush painting equipment. If there is much painting to be done, the labor required to brush paint will off-set the cost of good spray painting equipment.

c. Spray painting is the best way to paint concrete, rough lumber, wood shingles, farm machinery, fences, and farm buildings that have few openings.

2. Spray Painting Tools

Spray painting tools include the following:

Suction or Pressure Type Gun - The pressure type is recognized as the most popular spray gun.

Air Compressor

Paint Pressure Tank

Hose to convey air and hose to convey materials (paints)

Air controlling device (gauge and regulator on tank)

Transparency No. 1

3. The Spray Gun is Made Up of the Following Parts

   a. Air Cap - This cap controls the spray pattern, and the amount of air consumed. There are two types of caps - external and internal.

   b. Fluid Tip - The fluid tip is a nozzle through which the paint passes to enter into the stream of air. It is located just back of the air cap. Fluid tips help regulate the amount of paint flow, and it can be found in different sizes.

   c. Fluid Needle - This needle enters the fluid tip and permits the paint to flow, or it stops the flow.

   d. Trigger - The trigger pulls the needle out of the fluid tip or forces it back into the tip. Forcing the trigger to the rear opens the air valve on nonbleeder types of guns. If the trigger is further depressed the paint valve is opened.

   e. Fluid-Needle Adjustment Screw - The amount of paint that passes through the fluid tip is regulated by an adjustment screw.

   f. Air Valve - This valve is found on nonbleeder type guns. The passage of air through the gun is controlled by the trigger movement.

   g. Spreader Valve - The spreader adjustment valve controls the air flow to side holes located on the air cap.

4. Types of Guns and Cups

   a. The two types of guns are:

      Nonbleeder-Type - Air flow is shut off when the trigger is released in the nonbleeder gun. The air and paint is controlled by the trigger.

      Bleeder-Type - The air flows constantly through this gun. Paint flows through the fluid tip when the trigger is squeezed.

   Transparency No. 1

   b. The two types of cups are:

      Suction Cup - This cup has a bent hole that permits the outside pressure to enter the cup and help force the paint into the gun. The air stream that passes the end of the tip draws the paint forward. Paint should be thinned for the suction cup. The paint nozzle extends beyond the air cap opening where it is atomized. Suction cups are one quart or less in size, and they are attached to the gun.

Pressure Cup - This air-tight cup may be as large as two quarts. Air pressure entering the cup forces paint from it as the trigger is squeezed. The paint or fluid tip is flushed with the air cap opening. Usually, a smoother finish can be made with the pressure cup than with a suction cup because the air is used for atomization instead of siphoning. Pressure guns can handle heavier paint than siphon guns.

5. Pressure Tanks

   a. Pressure tanks are used for handling a large volume of paint. Unlike the pressure cups, the tanks are used to cover larger areas. Most tanks range from two to more than 100-gallon capacity.

   b. Air pressure enters the tank through a regulator that is mounted on the lid. The gun's front hose supplies paint, and the back hose supplies atomizing air to the gun.

6. Selecting a Spray Gun

   a. Nonbleeder guns are used with a tank or cup of compressed air. The air is regulated to a constant pressure. Bleeder guns are used with a continuous running compressor.

   b. A pressure-type gun will spray paints that are heavier than light enamels and lacquers.

   c. Internal-mix nozzles are used with pressure equipment and slow drying paints. The paint and air are mixed inside the nozzle. This type of nozzle is used where ordinary finish is desired.

   d. External-mix nozzles are operated by either suction or pressure. They can be used with heavy or light paints to form elongated or round patterns. More air pressure is required for operating than for the internal mix nozzle.

7. Using the Spray Gun

   a. Preparing Surfaces - Surfaces for spraying are prepared in the same manner as surfaces for brush painting. For example, wood and metal surfaces are cleaned of dirt, grease, moisture, and in some cases, old paint; concrete is allowed to weather in order to neutralize the alkalis present in the cement.

   b. Accessories such as ladders, scaffolds, lights, and dropcloths are used for both brush and spray painting. Usually, more protection is needed for border areas when spray painting than is needed for brush painting. Some of these protective measures include:

Covering shrubbery, walks, floors, windows, and doors.

Placing a cover over parts of machinery, trucks, and tractors that do not need painting with the immediate coat.

Protecting with a cover or not painting when wind may move the spray to adjoining objects.

c. Spray painting may require the use of a respirator and the removal of fumes from the area where the painting is being done. Safety precautions should be observed when painting around fires. Smoking is dangerous when painting.

d. Mixing, thinning, and straining are very important steps to observe when using a spray gun. The steps are:

When mixing paint for brush or spray painting, pour off the oil or thin material into another can, stir the pigment, and remix it with the thin material. The cup or tank is not used as a mixing container.

The adding of a thinner to paint will prevent it from running, but it also reduces the thickness of the paint film.

Paints should be strained through a fine wire screen or an old nylon hose before spraying. Even though a wire screen is used over the bottom of the fluid tube, it is still necessary to strain the paint.

e. Adjust the gun as follows:

Open spreader adjustment valve.
Open fluid needle screw - first thread is visible.
Check air leaks and then connect hose to cup.
Remove atomizing nozzle, press trigger until paint passes through gun.
Replace nozzle and set pressure.

8. Spraying Surfaces

Transparency No. 2

a. Distance of Gun from Surface - The gun should be held 6 to 8 inches from the surface. A good place is to place the thumb on the nozzle (air cap) point and stretch the fingers forward to the surface. Incorrect distance causes the following problems:

If the gun is held too closely the paint is put on thickly. If the surface is vertical, the paint will sag.

If the gun is held too far away from the surface, a sandy finish and excessive dusting will result, causing an inferior finish.

Transparencies Nos. 3 and 4

b. Gun Position - The correct position to hold a spray gun is vertically to the surface. It should also be moved in a parallel line to the surface. The overlap should be about 50% of each previous lap on the surface. Several problems may develop if the gun is held improperly. The problems may include:

Uneven covering will develop if the gun is arced at each end of the stroke. Excessive overspray develops where the gun passes near the surface.

If the gun is pointed upward while painting, the pattern will be heavy at the bottom. If it is pointed downward, the pattern or coat will be heavy at the top.

The trigger should be pulled just after the stroke begins and released just before the stroke ends, otherwise the pattern may be heavy at the beginning and end of each stroke. A light pull on the trigger may cause feathering and a small pattern. This practice is desirable when a stroke is butted next to another.

c. Painting Edges and Corners - Edges and corners should be sprayed before spraying the flat surfaces. Inside corners should be sprayed by making strokes over each face of the corner surface separately. Both sides of an outside corner are painted with one stroke,

d. Slender Surfaces - The circle of a spray pattern should be just large enough to cover the surface. Excessive over-spray will result if the pattern is too large.

e. Round Surfaces - Round work is sprayed by following the curve with the pattern. The strokes should conform with the round surface.

9. How to Clean a Gun

a. It is necessary to use a good solvent, such as paint thinner, painter's naphtha, or benzene to thoroughly clean the painting equipment.

b. Spray gun cleaning steps include:

Clean the cup or tank with a solvent.

Add solvent to the clean container and blow it through the gun with compressed air.

Take the nozzle apart and clean the parts in the solvent.

If a tank is used, run enough solvent through the hose to completely clean it of all paint.

Wipe the equipment clean and remove excess solvent.

Place the nozzle parts of the gun (still attached to the gun) in a solvent if it is idle for an hour or two. Some paints will dry within an hour or two on the nozzle.

References:

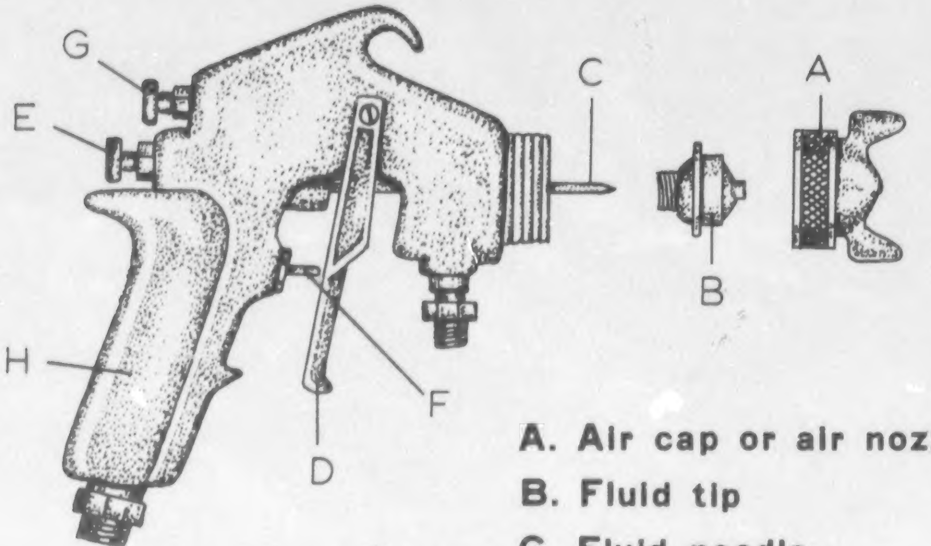
1. Foss, Edward W., Construction and Maintenance for Farm and Home, John Wiley and Sons, Inc., New York, NY, 1960.

2. Wakeman, T. J. and Vernon Lee McCoy, The Farm Shop, The Macmillan Company, New York, NY, 1960.

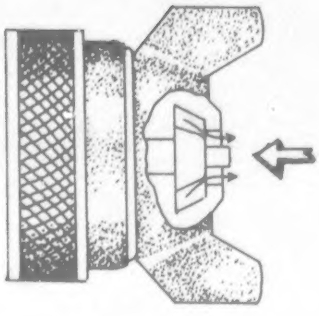
3. "Spray Painting," University of Illinois, Urbana, IL.

4. "Spray Gun Motion Study," The DeVilbiss Company, Toledo, OH.

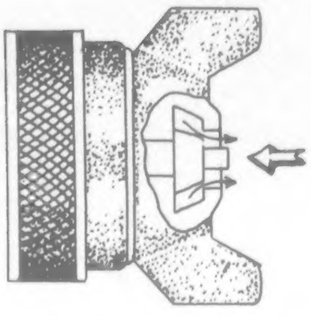
PARTS OF A SPRAY GUN



- A. Air cap or air nozzle
- B. Fluid tip
- C. Fluid needle
- D. Trigger
- E. Fluid adjust screw
- F. Air valve
- G. Spreader adjustment valve
- H. Gun body

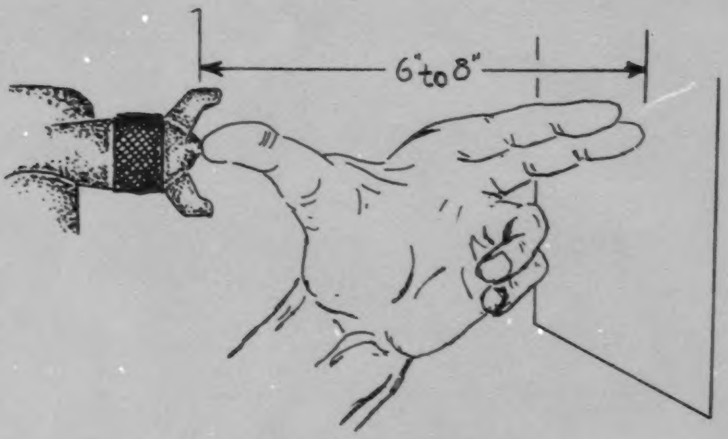


suction nozzle

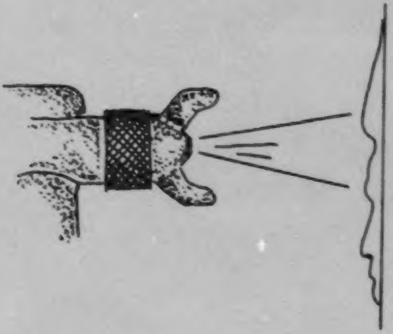


pressure nozzle

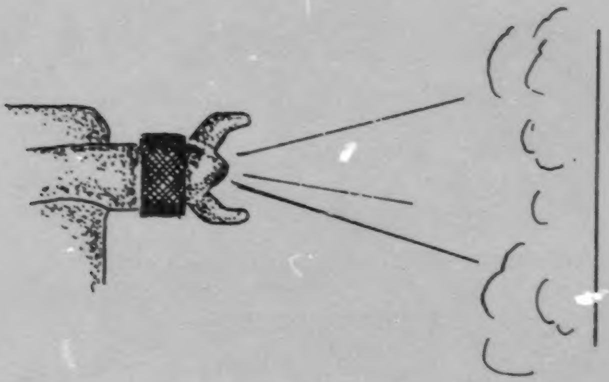
SPRAY GUN POSITION



correct distance from surface

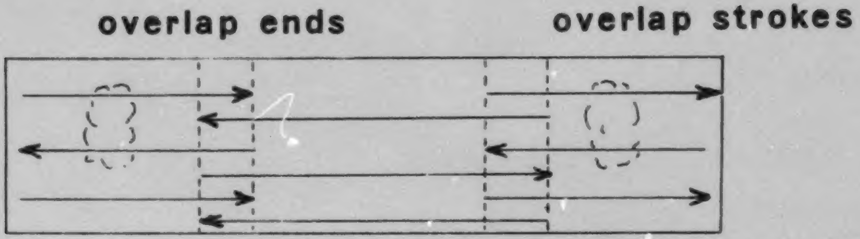


too close to surface



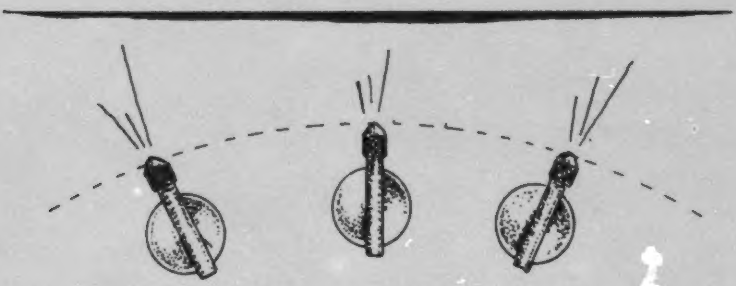
too far from surface

USE OF SPRAY GUN

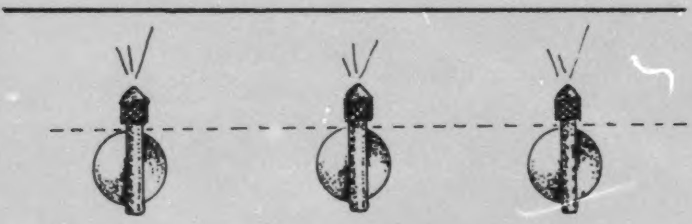

overlap ends
overlap strokes

Overlap each parallel stroke

Overlap end of stroke

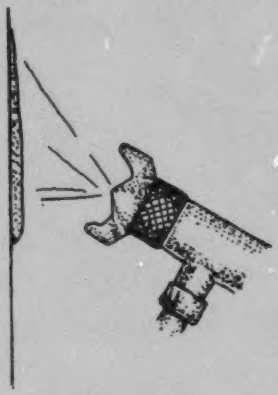


excessive overspray created by arcing

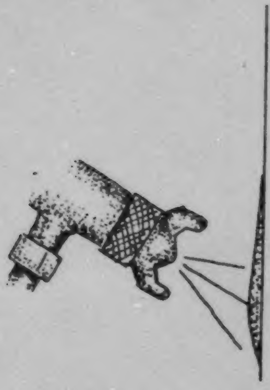


move gun in straight line

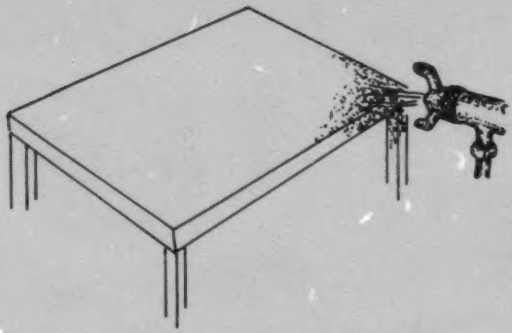
USE OF A SPRAY GUN



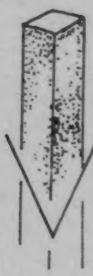
nozzle pointed upward



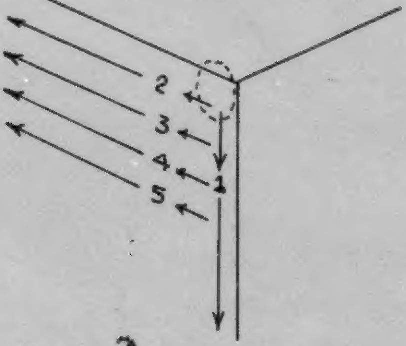
nozzle pointed downward



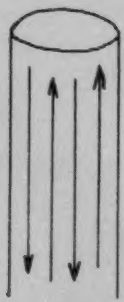
first spray edges and corners



spraying slender work



correct way to spray corners



small round work sprayed parallel

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AGRICULTURAL MECHANICS

Unit E: Conditioning Hand Tools (Wood and Metal)

Topic 1: Plane Iron, Wood Chisel, Bits (Wood and Metal), Screwdrivers, and Cold Chisel

Suggested Procedures and Activities: Sharp tools and tools that need sharpening may be used as teaching aids during the class discussion. Transparencies should be used if available.

1. The Grinding Wheel

   a. The grinding wheel is one of the most important pieces of equipment in the shop. If the wheel is used properly, it remains free of soft materials such as wood, rubber, aluminum, brass, copper, bronze, lead, tar, paint, and clay materials. A wheel that contains one or more of these materials usually becomes glazed. Another important feature of a conditioned grinding wheel is its squareness across the face.

   b. In order to restore the wheel to the desired working condition it may be necessary to remove the glazed or loaded surface with a grinding wheel dresser. The most commonly used dressers are as follows:

      Huntington Dresser - The wheel is sharpened as the star-shaped cutters are held against the wheel as it rotates.

      Diamond Dresser - A diamond set in the end dresser removes grains of abrasive as it is held against the wheel.

      Diamond-Carbon Dresser - A hard abrasive held in the tube removes particles from the rotating wheel as the dresser pressure is applied to the wheel.

      Abrasive Stick - A grinding wheel is dressed or trued when an abrasive stick or an old piece of a grinding wheel is pressed squarely against the wheel.

2. Proper Grinding

   a. Grinding of sides of the wheel can be successful if a special side grinding wheel is used, otherwise the shape of the wheel may be spoiled and the edge tool burned.

b. Hollow grinding is recommended for all hand tools and knives.

c. It is recommended that a tool be moved back and forth over the wheel to prevent heating. High speed steel tools may overhead while grinding. They should not be dipped into cold water for chilling. High speed steel often cracks when dipped in cold water.

d. Some tools are not usually sharpened by using a grinding wheel. Regardless of the method employed to properly grind tools such as small knives, scissors, divider points, ice picks, awls, and many other small tools; there is always a possibility of destroying the temper in the point or cutting edge.

3. A Comparison Between Conditioning a Plane Iron and a Wood Chisel

a. A plane iron is mounted in a frame so that the depth of cut can be controlled and even pressure and movement can be applied; otherwise, it is similar to the wood chisel.

b. The plane iron and the wood chisel are similar in the following ways:

The grinding and whetting are done on one side only.
The bevel length is twice the thickness of the blade or iron.
An angle of 25 to 30 degrees is considered standard.
The blade should be kept sharp at all times and used correctly on wood.

c. The major difference in sharpening a plane iron and wood chisel is the rounding of the corners or the blade edge of a plane iron. Wood chisel corners are left square. Square corners on a plane iron may leave grooves, especially if the board is wider than the blade.

4. How to Determine When to Sharpen Plane Irons and Wood Chisel Blades

a. A close check of the iron or blade may reveal the following conditions:

The tool is dull and only needs whetting.

Nicks are found in the cutting edge.

The cutting edge is not square.

The concave bevel has been honed away causing a need for grinding the tool.

Medium bevels are considered to be about 1/4 inches long,which may be too short for paring and too long for mortising.

Blue spots (over-heated areas) may appear near the cutting point, revealing that areas have been burned and have lost their original hardness.

The plane iron may have square corners, and the wood chisel may have round ones.

b. Another easy way to determine when there is a need to sharpen the tools is the quality and quantity of work being done. More time is required to complete a project with dull tools than with sharp tools. Also, there is a better quality of workmanship on the project if sharp tools are used.

Transparencies Nos. 1 and 2

5. Grinding and Honing the Wood Chisel and Plane Iron

a. Steps for jointing plane iron are listed below:

Place the iron or blade on the tool rest with the bevel pointing up.

While holding the iron bevel on the tool rest, touch it very lightly against the wheel and move the iron from left to right until the nicks are removed.

Check the edge for squareness.

b. Grinding a blade or iron is accomplished in the following manner:

Use a flat tool rest and adjust to proper angle for grinding the blade or iron at 25 to 30 degree angles.

Grind the chisel blade to an angle slightly shorter or slightly longer than 1/4 inch, depending on the type of work to be done. A plane iron bevel is about 3/16 inch long.

While grinding a blade or iron, lay it flat on the adjusted tool rest, and move it from side to side, keeping it perpendicular to the face of the wheel. Grind until a wire edge appears on the flat side.

Dip the blade or iron in water occasionally to keep it cool.

Check the blade or iron frequently for squareness by using a try square; use a template to determine the correct angle of the bevel. The angle (25 degrees) can be obtained by setting a T-bevel on the numbers 3 and 6 of a carpenter's square.

c. Hone the blade or iron by using the following steps:

Put the final finish on the cutting edge by honing it on an oilstone. Use a few drops of oil before laying the flat side of the blade on the oilstone to help remove the wire edge; reverse the position and hone the angle until the wire edge disappears.

After the wire edge is removed, the bevel is placed against the oilstone. To adjust the desired angle, rock the blade or iron back and forth until the angle is flat on the oilstone surface.

Move the plane iron or chisel blade in a back-and-forth motion with both hands moving parallel to the stone. Keep the oilstone surface moist with oil to prevent the fine steel particles from entering the stone's pores.

Round the plane iron edges by honing. This step is not required when honing a chisel blade.

6. Reshaping Auger Bits

a. Auger bits should be sharpened for the following reasons:

The auger bit consists of two cutting lips, two cutting spurs, a feed screw, the twist, shank, and tang. If any cutting part of the bit strikes a nail or other metal, the part is either dulled, nicked, or bent; therefore, it is necessary to recondition the bit. Quality workmanship cannot be done with a dull or damaged bit.

A rusty auger bit will fail to cut properly if the twist is rusty. It is more difficult to use due to the friction caused by a rough surface in the twist.

Transparency No. 3

b. Reconditioning auger bits is usually done with a file. The steps for fitting a bit are listed below:

Straighten the cutting spurs if they are bent inward or outward. The spurs can be placed on a piece of thin flat metal and tapped lightly with a hammer.

Hold the bit at a slight angle while filing the lips. Both lips should be filed at about a 25 degree angle. The lips and spurs are filed only on one side or surface, except for removing a wire edge that may be formed on the unfiled side.

Remove rust from the twist by oiling the entire bit,and polish the twist by pulling a piece of small rpoe through it. The outside flat surface of the twist can be cleaned by wiping it with an oily rag.

c. Some shops do not have the bit file; therefore, a small slim taper three-cornered file may be used to sharpen a bit if the individual is careful. A standard grinding wheel should not be used to reshape auger bits.

7. Reshaping Twist Drills

a. The reasons why a twist drill must be reshaped are:

Without proper drilling equipment many construction and repair jobs cannot be accomplished in the shop. Sharp drill bits are very important where hand drills (electric and manual) are used.

A drill bit that is dull, nicked, overheated, or sharpened improperly for specific jobs will result in inferior workmanship.

b. Drill bits should be checked due to the following reasons:

A 12 degree clearance behind the cutting edge is necessary to allow the cutting lips to cut into the metal.

Both cutting lips must be ground the same or the point will not be centered, and the bit will produce an oversize hole.

The lips must be ground to about 59 degrees with the axis, if the bit is to cut metal properly.

The bit point should be slightly rounded from the cutting edge to the heel. Rounding the point requires skill and exactness.

Transparency No. 4

c. The important steps to follow in sharpening a twist drill are:

Place the drill point against the grinder wheel (both point and shank at the same height). Use both hands if possible. The drill should be held at a 60 degree angle to the wheel.

Use one hand near the bit point and wheel; raise the bit cutting point and at the same time lower the shank with the other hand during the grinding process.

Make slow strokes as the point is pushed against the grinder wheel. The drill bit should be slightly rotated clockwise as the point is forced on an upward sweep. Dip the bit point in water at frequent intervals while it is being ground to keep it from overheating.

Rotate the drill and grind the other lip in the same manner.

Use a template to check the proper angle after every few strokes. Also, check for a 12 degree clearance from the front of the cutting lip to the back edge (heel).

d. The same bit can be used for hard and soft metals. Hard materials cause heavy pressure to be applied to the drill bit; a bit with an angle of more than 59 degrees will have a tendency to do less gouging. This same bit can be used on soft metals. A 30 degree angle from the central axis is considered most practical for drilling wood.

e. Twist drills cut best when sharpened properly; therefore an amateur may prefer a drill sharpening attachment for the grinder. Free hand grinding is not difficult to learn with practice.

f. Proper lip clearance can be determined best by holding the drill bit in a horizontal position and level with the eye. While looking at the point line formed in the center by grinding both lips, one will see that is is 45 degrees to the cutting edge. If the small center line is more vertical than horizontal the bit is lacking lip clearance.

8. Reshaping Screwdriver Tips

a. Most agricultural mechanics shops are equipped with various kinds and sizes of screwdrivers. It is not uncommon to find several screwdrivers in a shop that need reconditioning either due to misuse or wear. A screwdriver can serve its best purpose if it is properly fitted to a certain size screw.

b. Screwdrivers should be refitted when the tips are nicked, beveled, thin, rounded, twisted, or too soft.

Transparency No. 5

c. Steps for refitting tips

A broken or worn tip can be refitted by the following procedure:

Join the end square by holding the tip at a 90 degree angle against the grinding wheel.

Shape both faces of the screwdriver by placing them high on the grinding wheel. Carefully push and pull the handle with one hand as the other hand helps guide the tip. Only light pressure is applied during the time the blade is in contact with the grinding wheel.

Dip the blade in water several times during the grinding process to cool. Use a screw head to determine the extent of grinding desired.

Grind both sides of the tip in the same manner as grinding the faces. The tip should be placed in a screw slot during the shaping process in order to make it the same width as the screw head. The sides may be shaped parallel 1/4 inch from the tip.

Final shaping of a tip may be accomplished by using a file or oilstone.

If a screwdriver tip is twisted, it may be reshaped by placing it on an anvil and tapping the twisted part with a ball peen hammer.

Badly worn or broken tips may need retempering after they have been reshaped. The temper may be withdrawn from the blade during reconditioning, thus causing the tip to be soft.

9. Reshaping Cold Chisels

a. The two main reasons for reshaping a cold chisel

Where shops do a considerable amount of metal work, the cold chisel is an indispensable tool. It is one of several tools that cannot be used unless it remains sharp.

The cold chisel is abused in the same manner as many other shop tools; it is nicked, broken, dulled, and the head is mushroomed if used extensively. It is not the most difficult tool to reshape, but it may need reshaping more often than many cutting and punching tools.

Transparency No. 6

b. Reshaping steps are listed below:

Join the cutting edge until all nicks or gaps are removed. Hold the chisel in a level position while moving the point from side to side across the stone.

Hold the handle part of the chisel with one hand and place the chisel body against the tool rest at about a 65 to 70 degree angle with the handle pointing down.

Use the fingers or thumb of the other hand to apply pressure and help guide the point from side to side on the wheel. A slight swing of the chisel handle will give the chisel a curved cutting edge. Dip the point in water frequently while grinding it to keep it cool.

Grind both sides of the cutting edge in the same manner.

Check for the desired angle of bevel. The angle should be checked during the process of grinding both bevels. An angle gauge may be determined by cutting a V 3/8 inch deep and 1/2 inch wide in a piece of thin metal. This template will have two 70 degree sides.

If a mushroom head is formed on the chisel, grind it off at the same time the chisel is being sharpened. Pieces of flying steel from the head may cause accidents.

If the chisel is ground to the point that it is too thick at the end, it may be necessary to heat the chisel, draw it out and retemper the cutting point.

References:

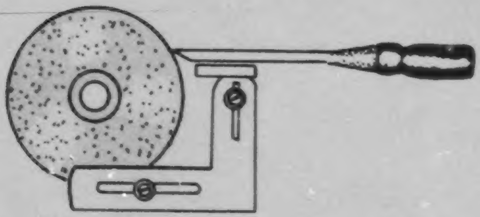
1. Foss, Edward W., Construction and Maintenance for Farm and Home, John Wiley and Son, Inc., New York, NY, 1960.

2. Phipps, Floyd J., Mechanics in Agriculture, The Interstate Printers and Publishers, Inc., Danville, IL, 1967.

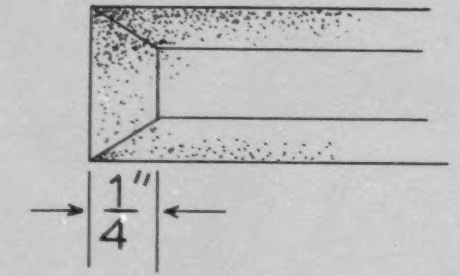
3. Wakeman, T. J. and Vernon Lee McCoy, The Farm Shop, The Macmillan Company, New York, NY, 1960.

4. "Sharpening Hand Tools," University of Illinois, Urbana, IL.

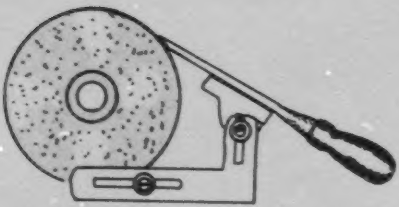
GRINDING WOOD CHISELS AND PLANE IRONS



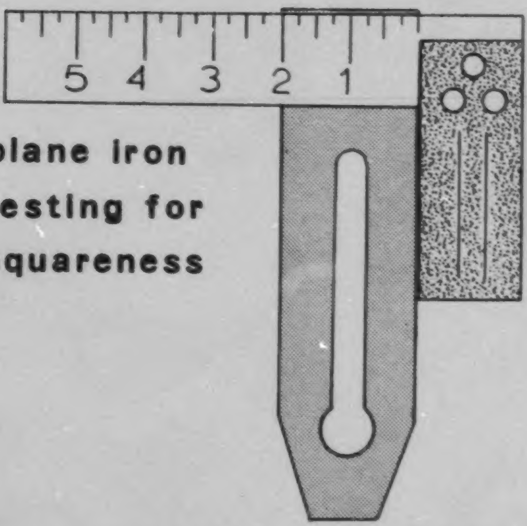
jointing a chisel



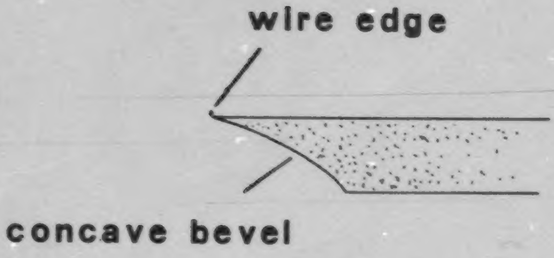
chisel bevel



grinding chisel

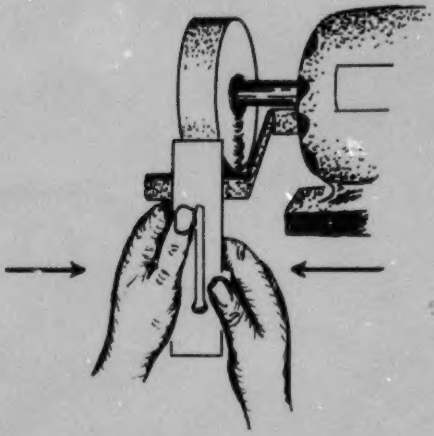


plane iron testing for squareness

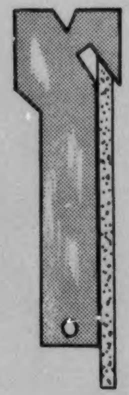

wire edge
concave bevel

plane iron

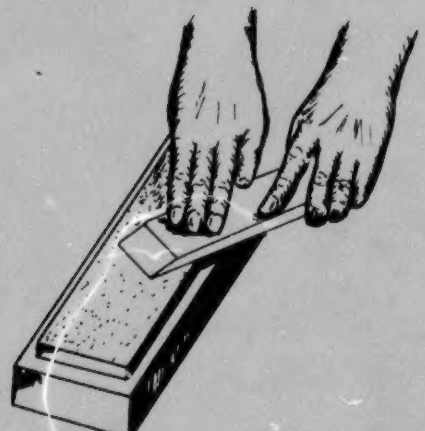
GRINDING AND HONING PLANE IRONS AND WOOD CHISELS



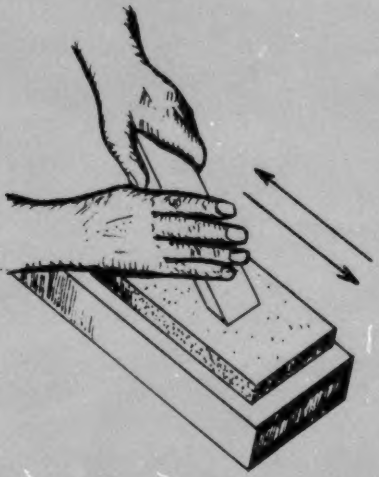
move iron from side to side



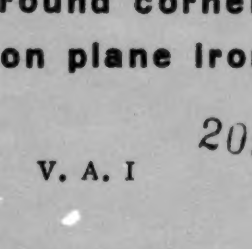
check angle of iron on template



remove wire edge on oilstone

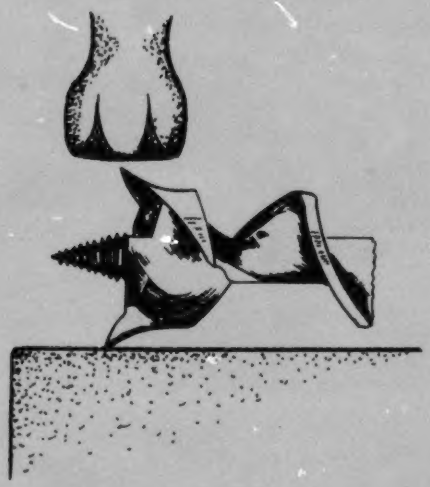


hone with back and forth motion

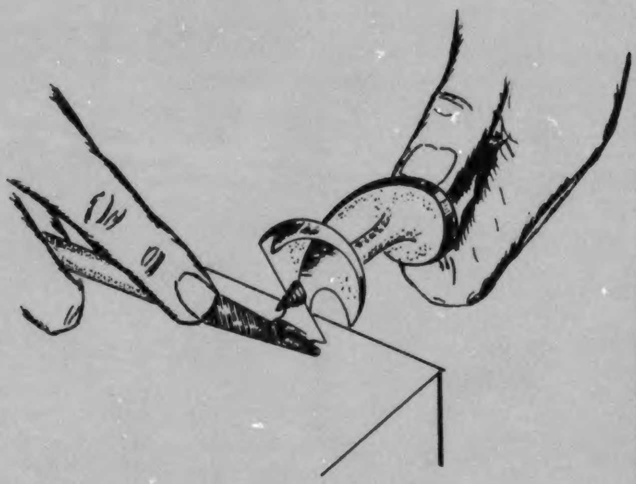


round corners on plane iron

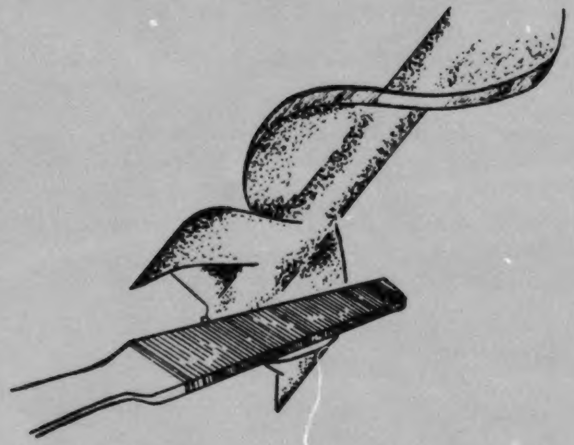
RECONDITIONING AN AUGER BIT



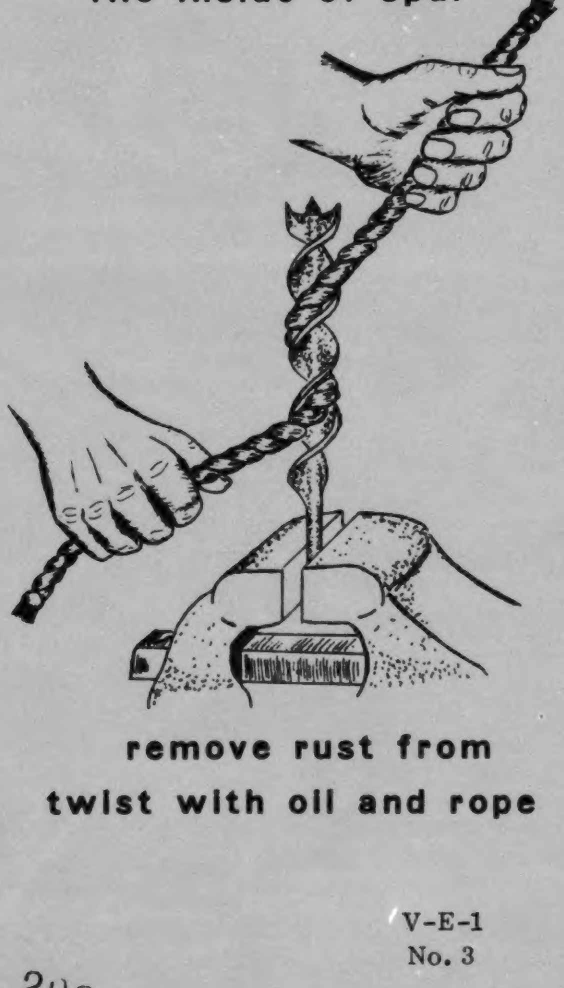
straighten spurs



file inside of spur

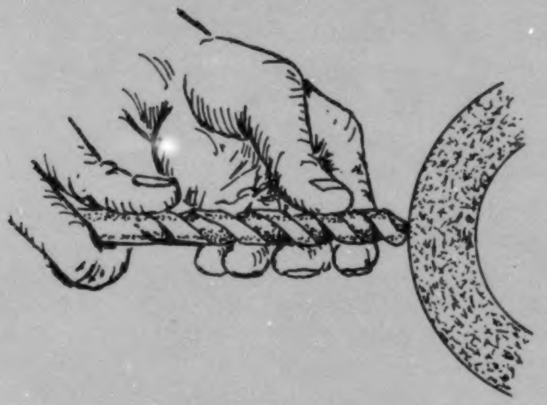


file lips at about 25 degree angle

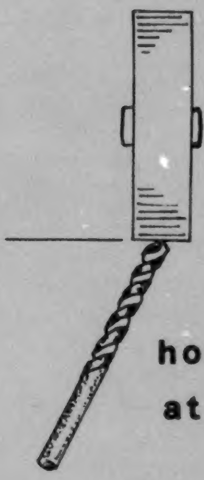


remove rust from twist with oil and rope

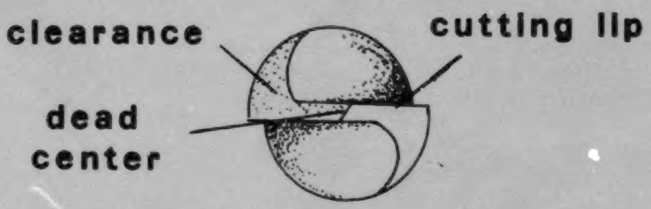
SHARPENING A TWIST DRILL



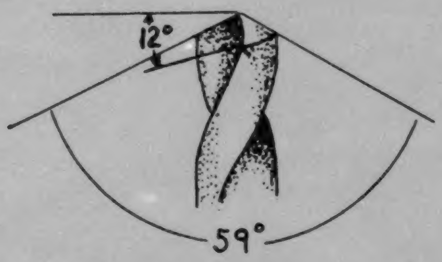
beginning sweep with drill



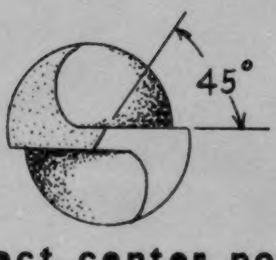
hold drill at angle


clearance
cutting lip
dead center

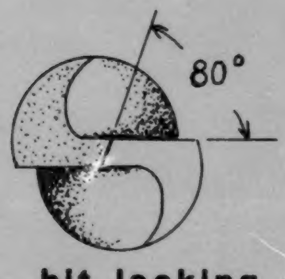
parts of bit



correct bit angles

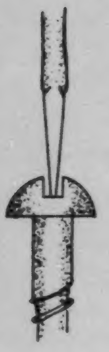


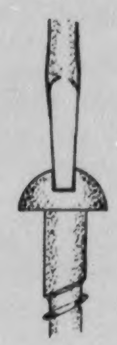
correct center point

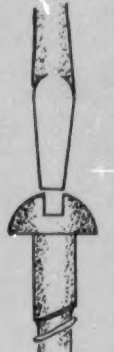


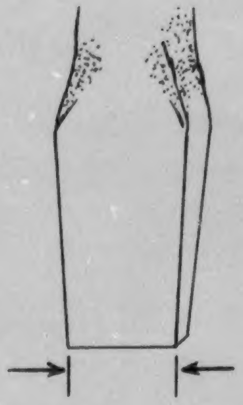
bit lacking clearance

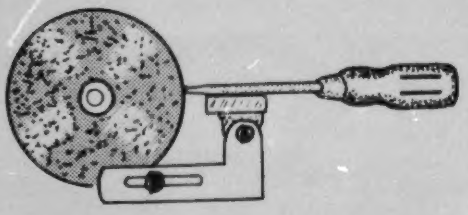
REFITTING SCREWDRIVERS

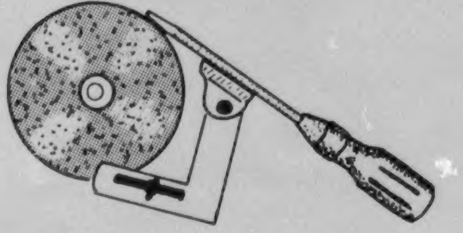

thin


correct

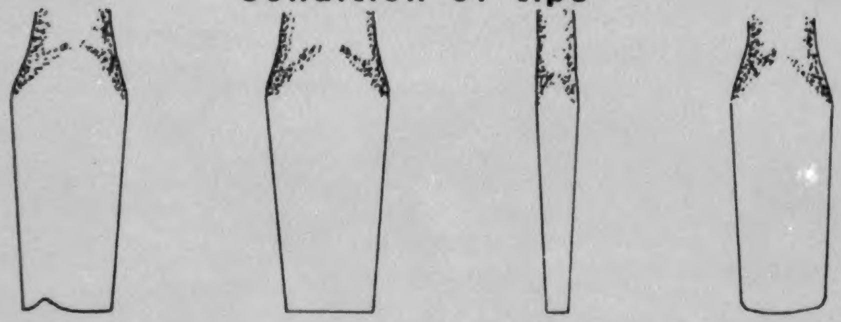

thick


width of tip

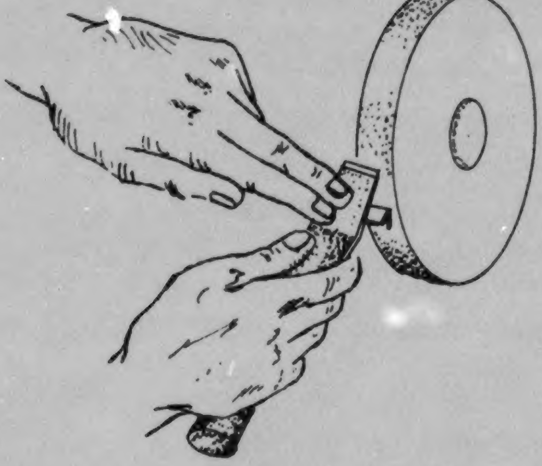

joint tip


grind tip

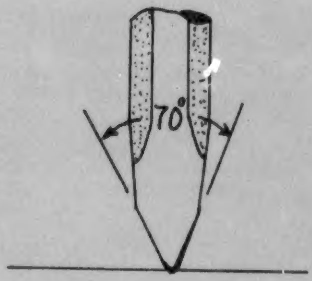
condition of tips


nicked correct rounded

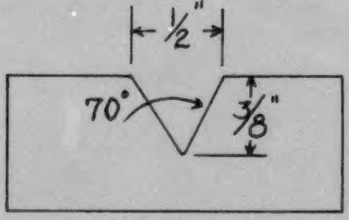
RECONDITIONING A COLD CHISEL



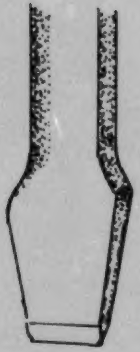
proper way to grind chisel



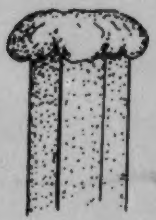
70° angle



template for cold chisel



proper bevel and rounded corners



mushroom head is dangerous

AGRICULTURAL MECHANICS SKILL SHEETS

B-4a	Reading the Micrometer
C-1	Charging and Servicing a Battery
C-2	Servicing the Spark Plug
I-1a	Adjusting the Spray Paint Gun
I-1b	Using the Spray Paint Gun
I-1c	Brush Painting a Wood Surface
L-1a	Arc Welding Single V-Butt Weld
L-1b	Arc Welding T-Fillet Weld
L-1c	Arc Welding Open Corner Joint
L-1d	Arc Welding Continuous Bead Pipe T-Fillet Weld
L-3a	Oxyacetylene Flame Adjustment, Turning On and Turning Off the Unit
L-3b	Oxyacetylene Cutting a Square Cut
L-3c	Corner Fusion Weld Without a Filler Rod
M-1a	Using the Hand Hack Saw
M-1b	Cold Cutting Thin Flat Metal
M-1c	Cold Cutting Round Metal
M-1d	Using the File
M-2a	Drilling a Hole With a Drill Press
M-2b	Threading a Bolt
M-2c	Threading a Hole For 3/8" Stud With National Coarse Threads
M-3a	Dressing a Grinding Wheel
M-3b	Reshaping a Cold Chisel
M-3c	Free-Hand Sharpening a Twist Drill
M-3d	Reconditioning an Auger Bit
M-3e	Sharpening Plane Irons and Wood Chisels
N-1a	Soldering Copper Tubing
Q-1a	Marking and Cutting Common Rafters
R-1a	Making and Using a Test Light
R-1b	Wiring a 120 V Light Circuit Controlled by a Single-Pole Switch
R-1c	Wiring Two Duplex Receptacles in a 120 V Circuit
R-1d	Wiring a 120 V Light Circuit Controlled by Two Three-Way Switches
R-2a	Checking Running & Starting Windings on Split-Phase Electric Motors
R-2b	Changing Direction of Rotation on Split-Phase Electric Motors
R-2c	Changing Direction of Rotation on Dual-Voltage Capacitor-Start Electric Motors
R-2d	Changing Voltage and Direction of Rotation on Repulsion-Start Electric Motors
T-1a	Differential Leveling
T-1b	Setting Up and Adjusting the Farm Level
T-1c	Laying Out Building Lines
T-1d	Setting Batter Boards for a Foundation

STUDENT ______________________

AGRICULTURAL MECHANICS B-4a

SCHOOL ____________

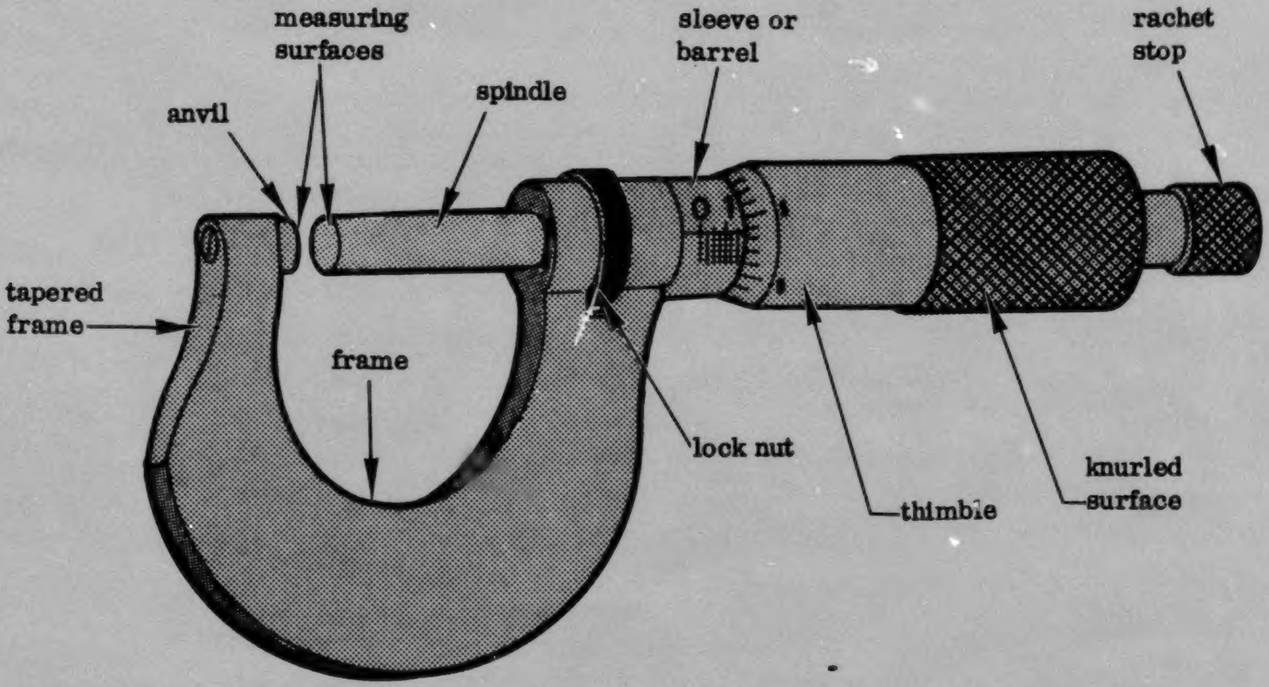
DATE ____________

SKILL SHEET - READING THE MICROMETER

Materials Needed:

Micrometers 0"-1", 1"-2", etc.
Flat, round, and square stock for practice measurements
Crankshaft or camshaft with tolerance specifications

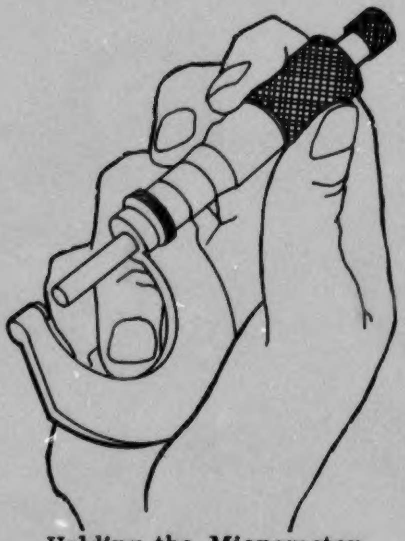
Parts of the Micrometer:


measuring surfaces
sleeve or barrel
rachet stop
spindle
anvil
tapered frame
frame
lock nut
thimble
knurled surface

Procedure and Explanation:

A. Hold the micrometer prcperly.

B. Turn the thimble with the thumb and first finger, and note that each complete turn indicates .025" on the sleeve or barrel. Every fourth line on the sleeve is longer than the others and stamped 1, 2, 3, etc. meaning .100", .200", .300", etc.



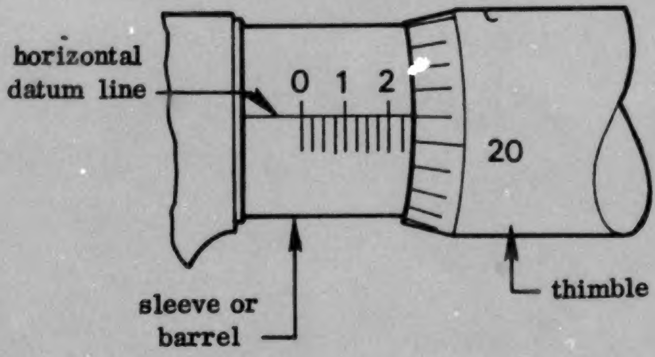
Holding the Micrometer

C. In turning the thimble, note the lines that indicate .001". Every fifth line on the thimble is numbered 0, 5, 10, 15, and 20 meaning .005, 010, .015, and .020. One complete turn of the thimble is .025".

D. In reading the micrometer, add the following measurements:
1. The smallest number of inches that can be read by the micrometer.
2. The figure on the sleeve that the thimble edge just passed; this indicates hundred thousandths.
3. The number of lines visible on the sleeve beyond the highest figure multiplied by .025".
4. The line on the thimble aligning with the horizontal line on the sleeve multiplied by .001".

Illustration Using 0"-1" Micrometer:

Smallest number of inches = .000"
Sleeve figure = .200"
Lines past figure x.025" = .025"
Line on thimble x.001" = .021"
Total Measurement = .246"

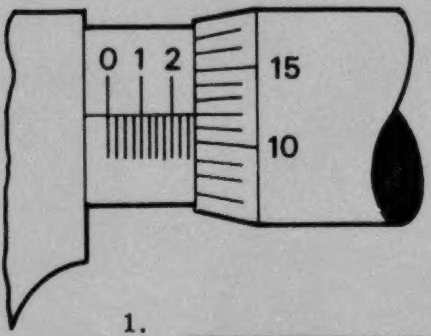


Steps in Taking a Micrometer Reading:

A. Clean the anvil and spindle face with lens paper.
B. Hold the micrometer by the frame and not the thimble.
C. Adjust the thimble with the thumb and first finger.
D. Do not force the item to be measured between the anvil and spindle.
E. Adjust spindle pressure to the correct tension or until the ratchet clicks twice.
F. Secure the thimble with the lock nut, remove the micrometer from the work piece, and then make the reading.
G. Take at least three readings on round stock and use the average as the actual shaft diameter.

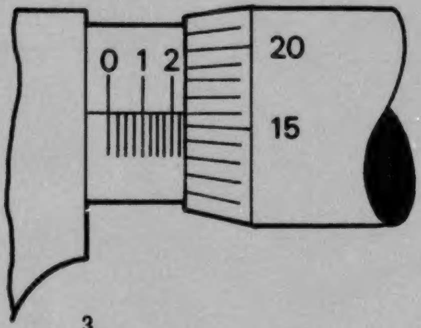
Skill Test on Various Size Micrometers:

A. Place the correct reading in the blank space provided by each of the micrometers below.



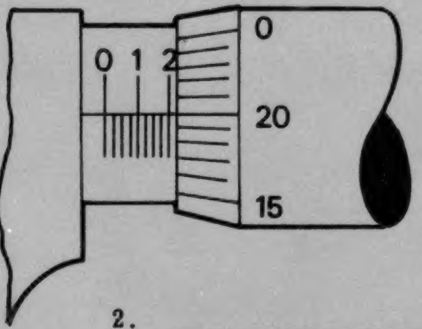
1. ______________

0" - 1" micrometer



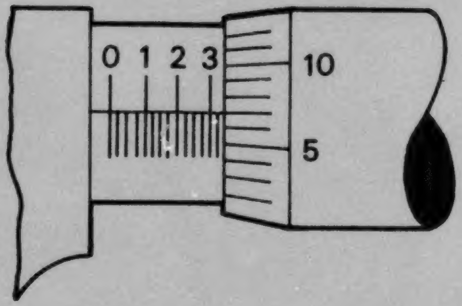
3. ______________

2" - 3" micrometer



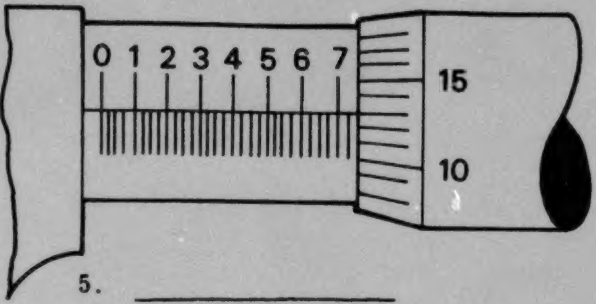
2. ______________

0" - 1" micrometer

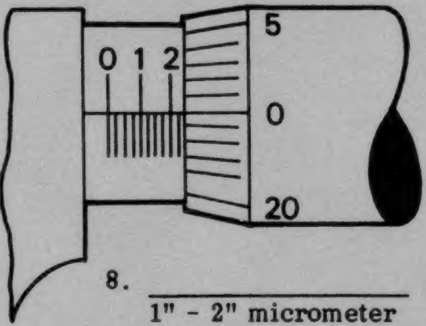


4. ______________

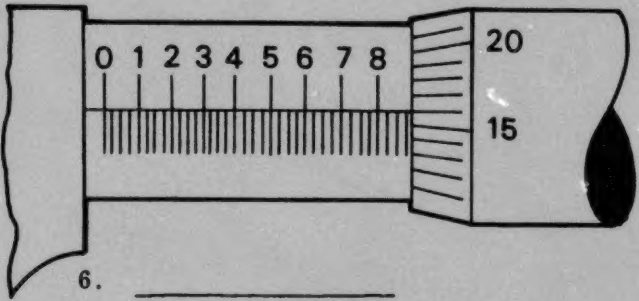
0" - 1" micrometer


0 1 2 3 4 5 6 7
15
10

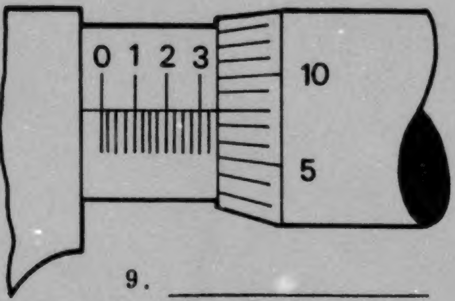
5. ____________________
5" - 6" micrometer



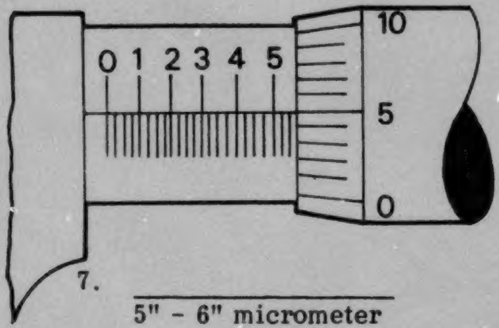
8. ____________________
1" - 2" micrometer


0 1 2 3 4 5 6 7 8
20
15

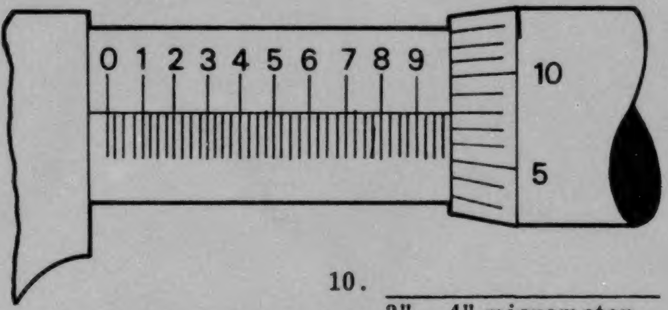
6. ____________________
1" - 2" micrometer



9. ____________________
0" - 1" micrometer


0 1 2 3 4 5
10
5
0

7. ____________________
5" - 6" micrometer


0 1 2 3 4 5 6 7 8 9
10
5

10. ____________________
3" - 4" micrometer

B. Measure assorted sizes of flat, round, and square stock provided by the instructor.

C. Measure crankshaft and / or camshaft and compare with specifications for tolerances.

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STUDENT ____________________ SCHOOL ____________

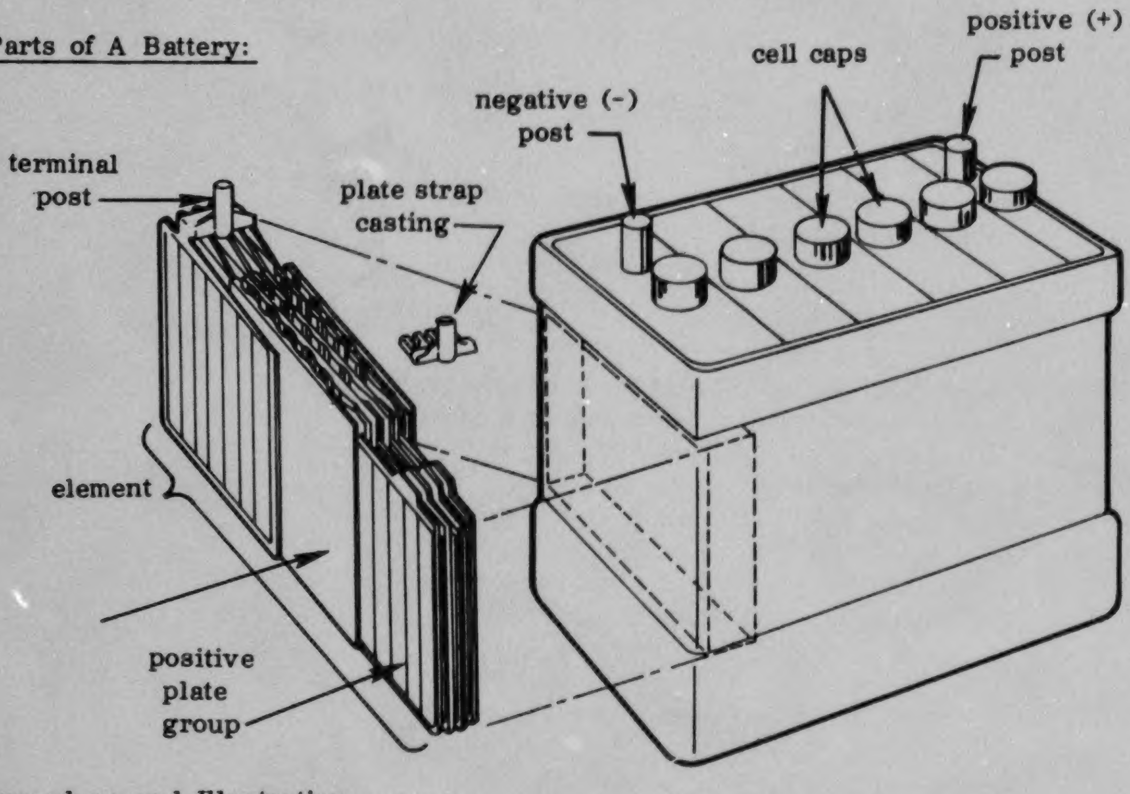
AGRICULTURAL MECHANICS C-1 DATE ____________

SKILL SHEET - CHARGING AND SERVICING A BATTERY

Materials Needed:

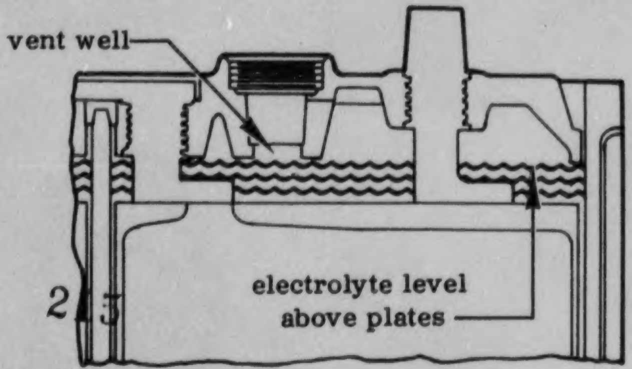
Cut - away battery or chart
Discharged battery with specifications
Battery charger and operator's manual
Distilled water, water and baking soda solution
Cleaning brush, wire brush, and a post and terminal cleaning brush
Hydrometer with thermometer for temperature corrections.

Parts of A Battery:


positive (+)
post
cell caps
negative (-)
post
terminal
post
plate strap
casting
element
positive
plate
group

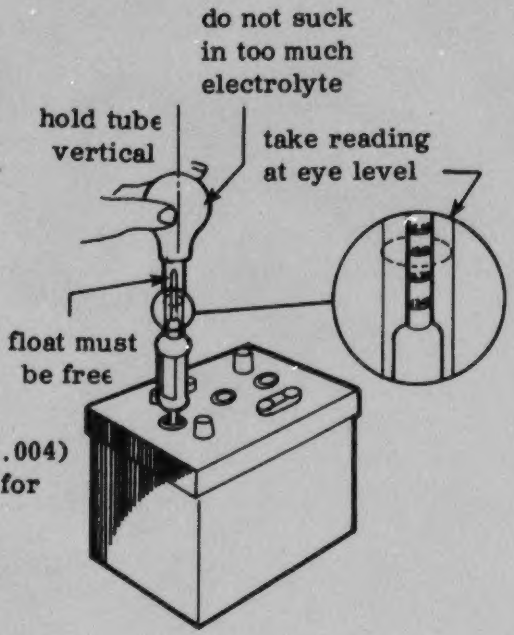
Procedure and Illustration:

A. Properly remove the battery from the vehicle and clean it, then remove the cell caps.
B. Check the electrolyte level (3/8" above the plate).
C. Add distilled water if necessary.


vent well
electrolyte level
above plates

D. Check the specific gravity of the battery. Correct the specific gravity reading in relation the electrolyte temperature. Take into consideration the climatic conditions. The variation between cells should be no more than .050.

State of Charge	Specific Gravity
Fully charged	1.260-1.280
75% charged	1.215-1.230
50% charged	1.170-1.180
25% charged	1.120-1.130
Discharged	1.070-1.080


do not suck in too much electrolyte
hold tube vertical
take reading at eye level
float must be free

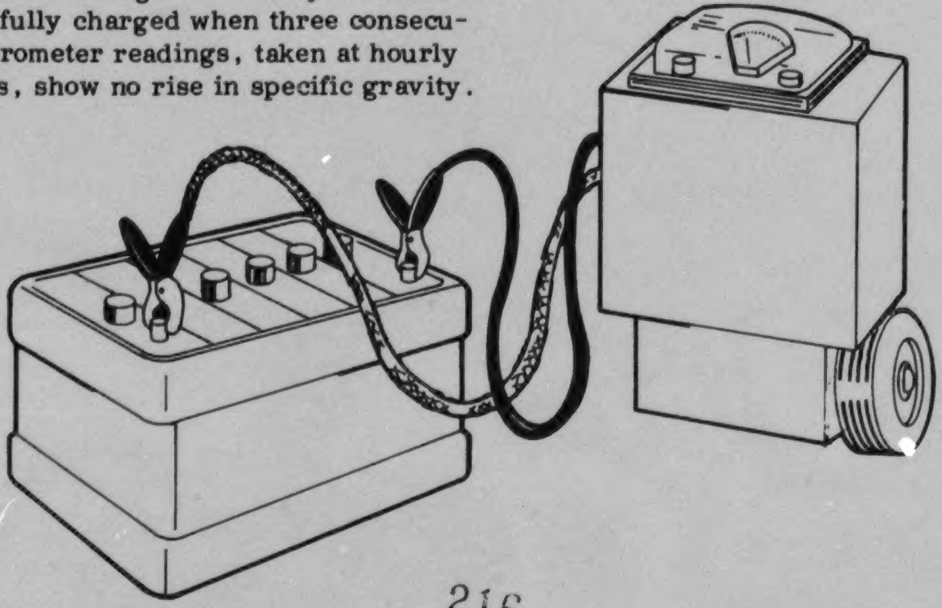
Temperature Correction

Add to the reading four gravity points (.004) for each 10° above 80° F. Subtract .004 for each 10° below 80° F.

E. Properly adjust and connect the battery charger.

F. Charge the battery at a moderate rate for two to six hours (moderate rate will prevent excessive boiling).

G. Periodically check the battery to determine the degree of charge. A battery is considered fully charged when three consecutive hydrometer readings, taken at hourly intervals, show no rise in specific gravity.



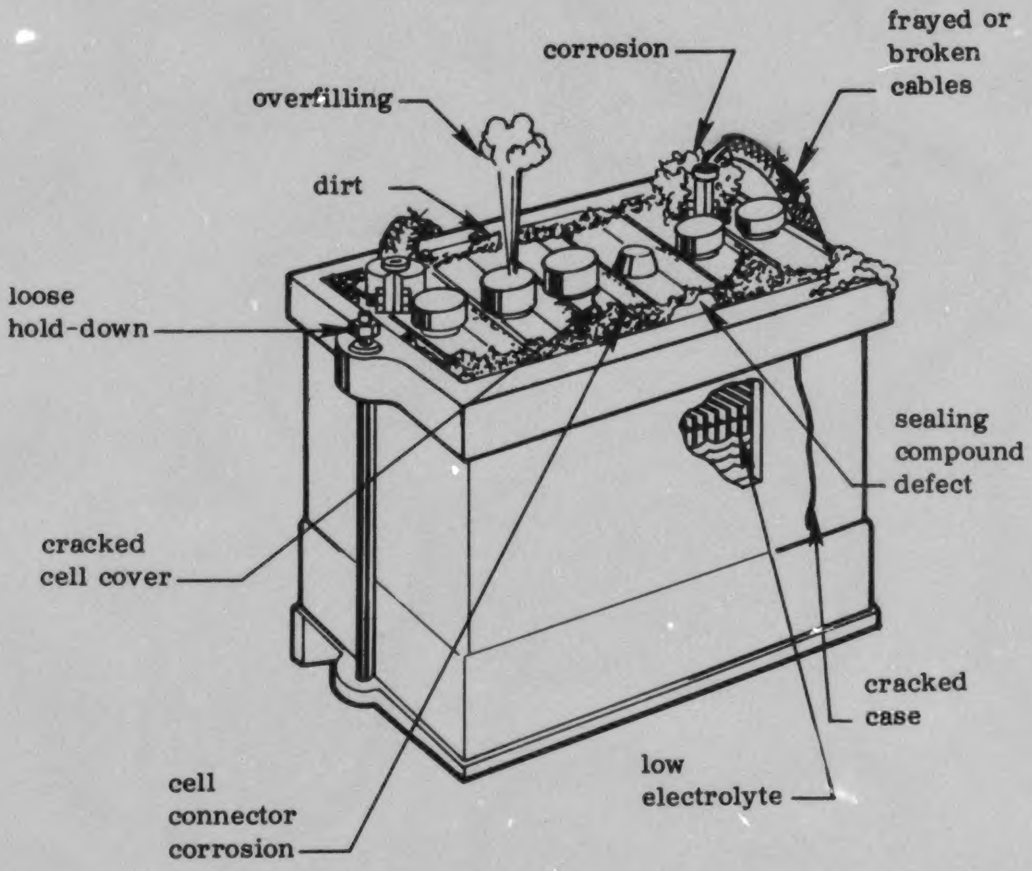
H. When the battery reaches full charge, turn off and remove the charger.
I. Replace the cell caps after rechecking the electrolyte level.
J. Rinse off any electrolyte which might have boiled out on top of the battery.

NOTE: Batteries are charged by reversing their flow of current by using an outside power source. Charging rates are fast, medium, and slow. If fast charging is used, never exceed 40 amps for a 12-volt battery or 70 amps for a 6-volt battery.

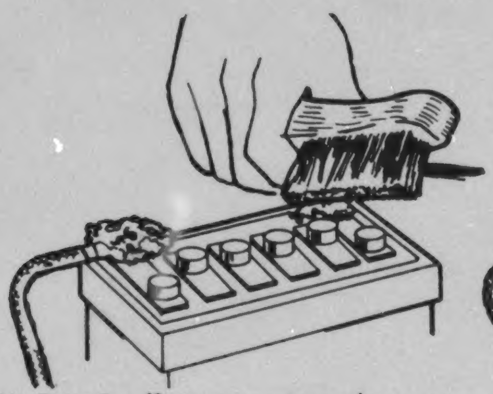
CAUTION: Avoid body contact with the electrolyte. Charging should only be done in an area free from flames and sparks due to the explosive hydrogen gas formed during the charging process.

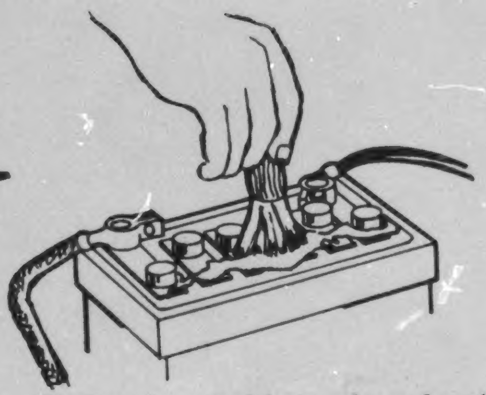
Servicing The Battery:

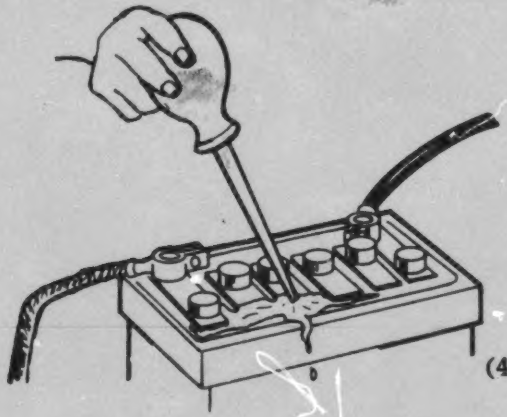
A. Periodic maintenance of the battery should include checking the points illustrated below:

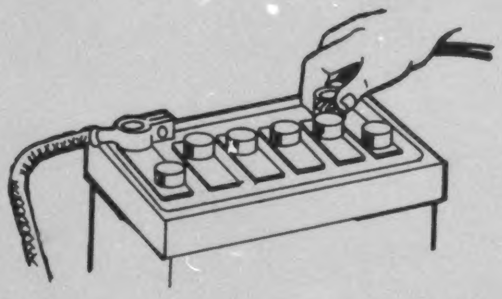

frayed or broken cables
corrosion
overfilling
dirt
loose hold-down
sealing compound defect
cracked cell cover
cracked case
low electrolyte
cell connector corrosion

B. The steps in removing battery corrosion are:


(1) Brush off excess corrosion.


(2) Brush on baking soda and water solution.


(3) Rinse with clean water.


(4) The terminals should be removed, cleaned, dried, greased, and replaced.

C. The steps in jump starting a battery are:

(1) Remove the caps from both batteries to allow dangerous gases to escape.
(2) Connect jumper cable to the positive (+) post of the dead battery.
(3) Connect jumper cable to the positive (+) post of the booster battery.
(4) Connect jumper cable to the negative (-) post of the booster battery.
(5) Connect cable to the engine block of the vehicle with the dead battery on the side away from the battery.
(6) After starting, remove the cable from the engine block and then the other end from the booster battery.
(7) Finally, remove cable from the positive (+) post of the recharging battery and then the positive (+) post of the booster battery.

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Student ____________________
Agricultural Mechanics C-2

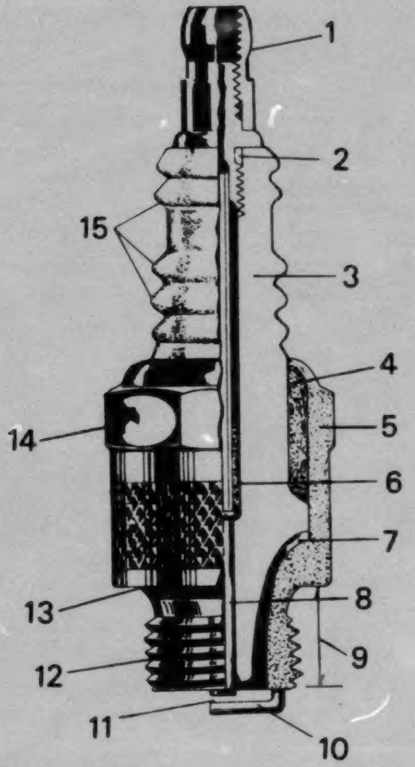
School ____________________
Date ____________________

SKILL SHEET - SERVICING THE SPARK PLUG

I. Materials Needed:

Engine needing spark plug servicing
New and used plugs
Operator's manual for vehicle
Compressed air supply and air chuck
Abrasive spark plug cleaner
Tags to mark wires
Deep spark plug sockets
Flexible ratchet handle
Wire plug gapping tool
Ignition file
Spark plug reference sheets
Wash pan, solvent, brush
Supply of spark plug gaskets
Torque wrench
Wire brush
Numbered spark plug rack

II. Identify the parts of the spark plug:



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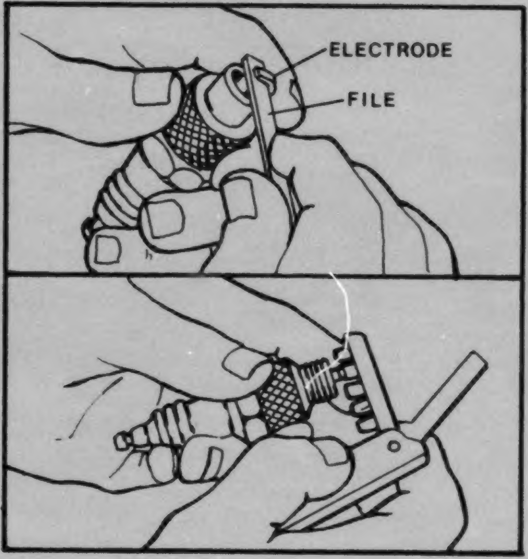
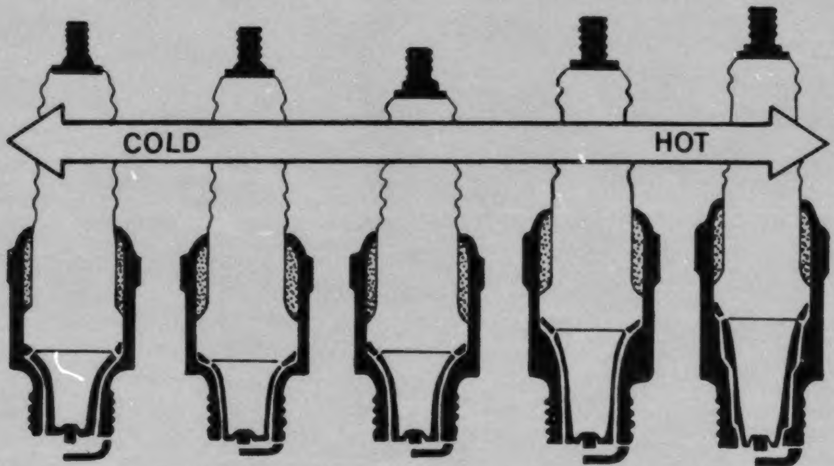
III. Procedure for Servicing:

A. Correctly remove plugs from an engine.
B. Compare the used spark plug gaskets to new ones.
C. Determine the engine condition based on the condition of the used plugs.
D. Wash the plugs with solvent and dry with air blast.
E. Clean the threads on the spark plugs.
F. Abrasive clean the spark plugs according to the recommendations of the manufacturer.
G. Use an ignition file to dress the electrode.
H. Check the plug gap and adjust it.
I. Use a commercial tester to test the plugs.
J. Install plugs with the correct torque.

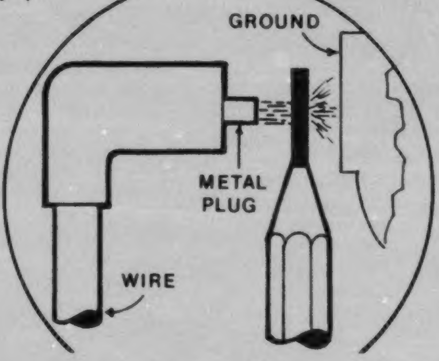


IV. Additional Suggested Student Activities:

A. Identify the type of fouling on a collection of spark plugs from different engines.
B. Study the difference between hot and cold plugs.



C. Demonstration for checking coil polarity. The wrong coil polarity can cause the grounded electrode to erode or "dish out".



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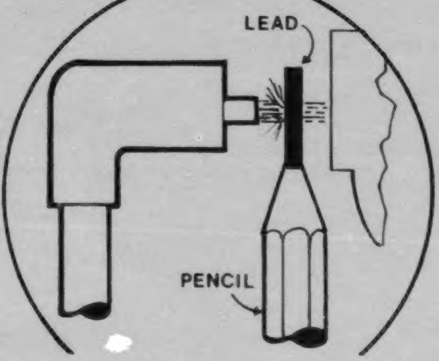


INCORRECT

STUDENT ____________________ SCHOOL __________

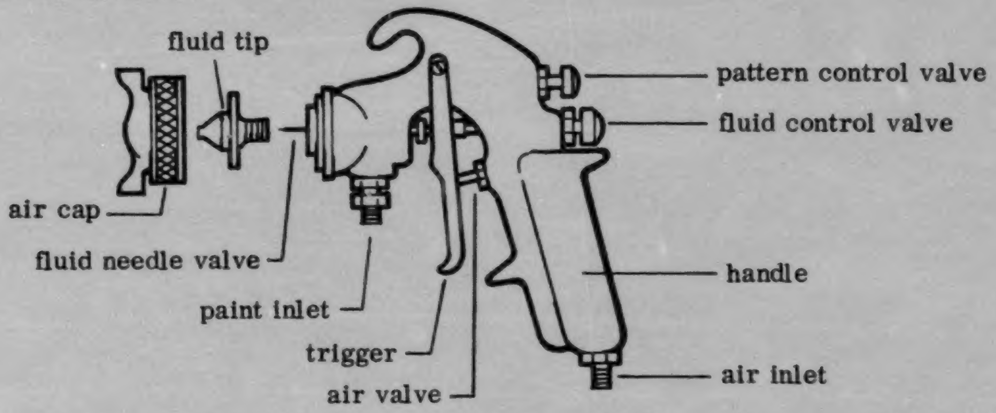
AGRICULTURAL MECHANICS I-1a DATE ___________

SKILL SHEET -ADJUSTING THE SPRAY PAINT GUN

Materials Needed:

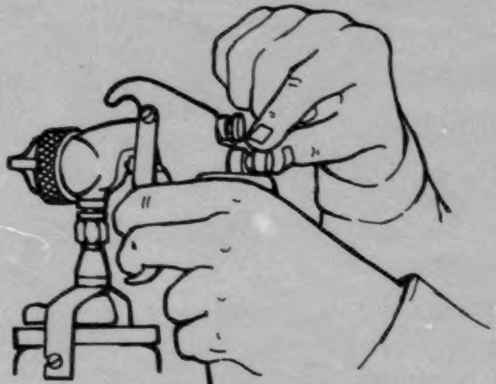
Compressed air, spray gun, hoses, and regulators
Thinner, solvent, and paint
Mixing container, paddle, strainers, and viscosimeter
Respirator and proper dress
Cardboard or paper pad for pattern testing

Parts Of A Spray Gun:

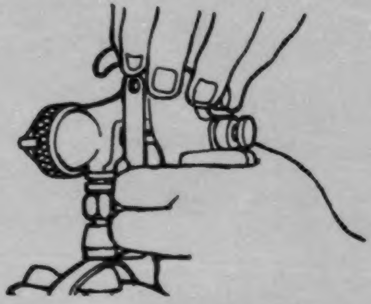

fluid tip
pattern control valve
fluid control valve
air cap
fluid needle valve
handle
paint inlet
trigger
air inlet
air valve

Procedure and Illustration:

A. Open the fluid control valve halfway for spot repair and fully for large panel painting.
B. Set the pattern control valve half open for small spots and fully open for large areas.
C. Test for leaks with thinner in the paint cup.



Setting fluid feed valve which controls the flow of paint through the gun.



Adjusting the pattern control valve which regulates the flow of air through the horn holes.

D. Adjust the pressure at the gun to 30-40 lbs. for lacquers. Enamels will require 55-65 lbs. pressure at the gun.

E. The most accurate method of measuring the pressure at the gun is to use an in-line regulator between the gun and hose.

F. If a second regulator is not available use the chart illustrated here.

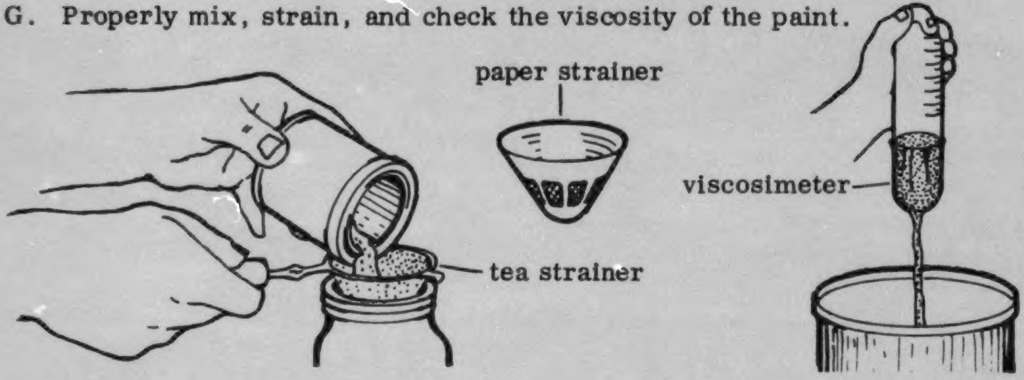
ESTIMATED AIR PRESSURES AT THE GUN

Based on Readings at the Transformer

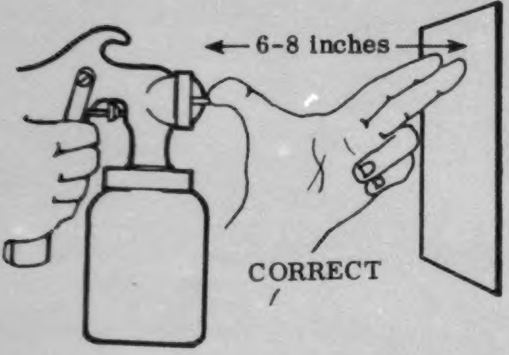
	PRESSURE READING (LBS.) AT THE TRANS FORMER	PRESSURE AT THE GUN FOR VARIOUS HOSE LENGTHS.					
		5 ft.	10 ft.	15 ft.	20 ft.	25 ft.	50 ft.
1/4 Inch Hose	30	26	24	23	22	21	9
	40	34	32	31	29	27	16
	50	43	40	38	36	34	22
	60	51	48	46	43	41	29
	70	59	56	53	51	48	36
	80	68	64	61	58	55	43
	90	76	71	68	65	61	51
5/16 Inch Hose	30	29	285	28	275	27	23
	40	38	37	37	37	36	32
	50	47	48	46	46	45	40
	60	57	56	55	55	54	49
	70	66	65	64	63	63	57
	80	75	74	73	72	71	66
	90	84	83	82	81	80	74

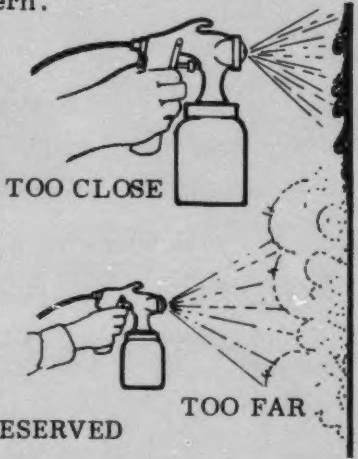
NOTE: Snap hose connectors will further reduce the pressure that reaches the gun by 1 pound. Pressures given are approximate and only apply to new hoses.

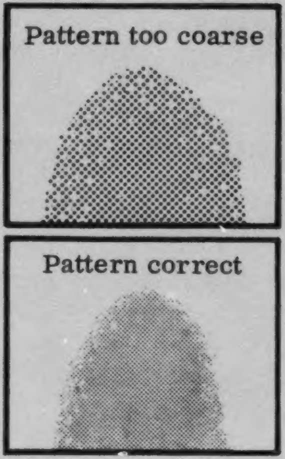
G. Properly mix, strain, and check the viscosity of the paint.



H. Hold the gun 6 to 8 inches from the cardboard or paper pad to test the pattern. If the pattern is too coarse increase the pressure. If necessary adjust the spray pattern.







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STUDENT ____________________ SCHOOL ______________

AGRICULTURAL MECHANICS I-1b DATE ______________

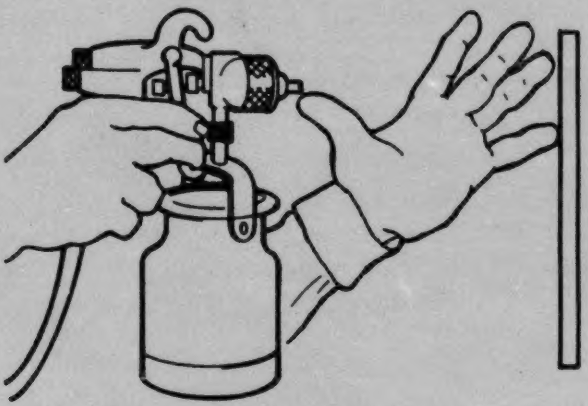
SKILL SHEET - USING THE SPRAY PAINT GUN

Materials Needed:

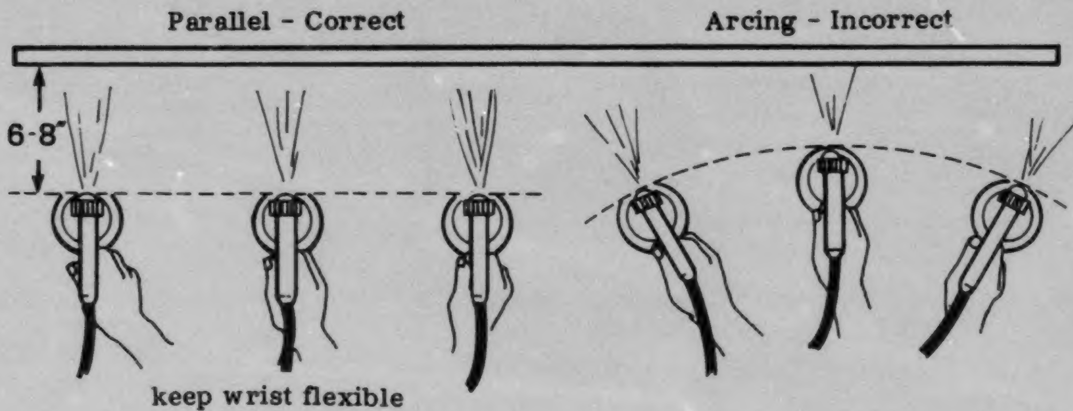
Compressed air, spray gun, hoses, and regulators
Thinner, solvent, and paint
Mixing container, paddle, strainers, and viscosimeter
Respirator and proper dress
Prepared surface to paint

Procedure and Illustration:

A. Adjust the paint spray gun.
B. Properly mix, strain, and check the viscosity of the paint.
C. Hold the spray gun at the proper distance from the surface. (6-8 inches for lacquers and 8-10 inches for enamel paints).

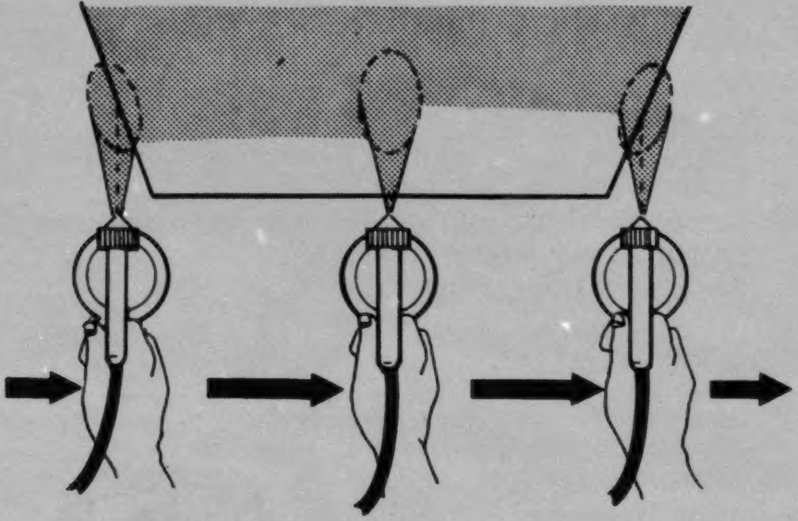


D. Keeping the gun at right angles to the surface, move the gun parallel to the surface with a steady deliberate pass, about one foot per second. Do not arc the gun, except when blending a spot repair.



keep wrist flexible

E. Release the trigger at the end of each stroke, then press the trigger again as the next stroke is started.



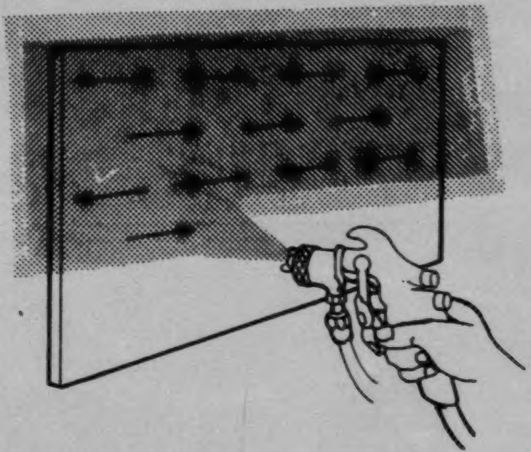
F. Start at the top of an upright surface. The gun should be level with the top, causing the upper half of the spray pattern to shoot off in space or hit the masking.

G. The second pass is made in the opposite direction. Overlap one-half of the previous pass.

H. Continue back and forth passes, triggering the gun at the end of each pass, lowering each pass one-half the width of the spray pattern.

I. The last pass is made with the lower half of the spray pattern being below the surface being painted.

J. This method of painting is called a single coat. Note the correct method of overlapping.

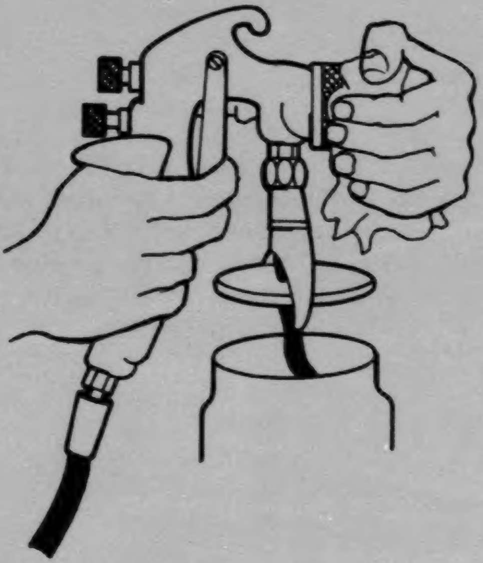


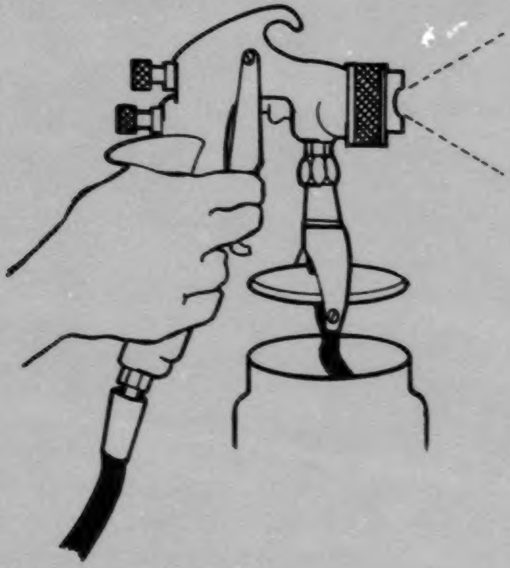
K. For multiple coats, repeat the single coat procedure. If using lacquers, repeat immediately. If using enamels, allow time for the first coat to set up (become tacky) before applying the second coat.

NOTE:

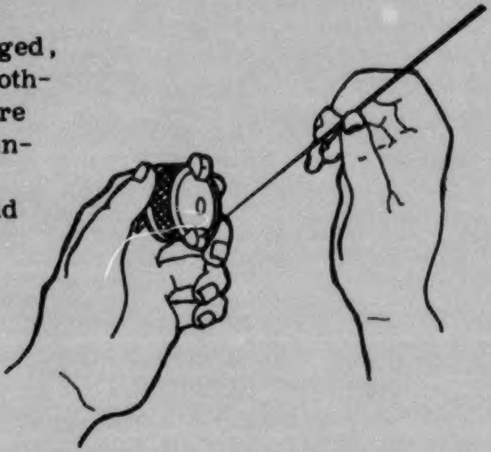
Many problems resulting from improper use of the spray gun may be observed. Runs and sags will result if the gun is held too close or moved too slowly. Runs and sags can also be caused by too much paint flow or too little air pressure. If the gun is held too far away or moved too rapidly a starved film will result. Excessive air pressure or holding the gun too far away can cause the orange peel appearance. Tilting the gun results in leaving a heavy film on the surface closest to the gun. Arcing the gun results in a heavy film in the middle of the swing as the pass is made.

L. Cleaning and care of the spray gun should be done as follows:
   1. Immediately after use, loosen the cup and lift the suction tube above the paint level. Unscrew the air nozzle about three turns, hold a cloth over the air cap, and pull the trigger. This will push the paint back into the cup.
   2. Remove the paint from the cup, refill the cup with about one inch of solvent, put the cup back on the gun, tighten the air nozzle, then pull the trigger to flush out the paint left in the gun.





3. Remove the nozzle, soak it in clean solvent, then dry it with compressed air. If holes have clogged, use a broomstraw or toothpick to clean them. Wire should not be used to unclog the holes because permanent damage could result.



4. Thoroughly clean the paint cup with solvent.
5. Replace the air nozzle and cap. Wipe the spray gun with a solvent soaked cloth to remove all traces of paint.
6. Lubricate the spray gun occasionally, in accordance with the manufacturer's specifications.

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STUDENT ______________________ SCHOOL ______________________

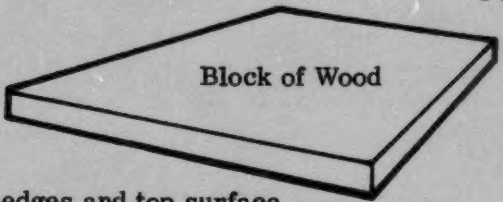
AGRICULTURAL MECHANICS I-1c DATE ______________________

SKILL SHEET - BRUSH PAINTING A WOOD SURFACE

Materials Needed:

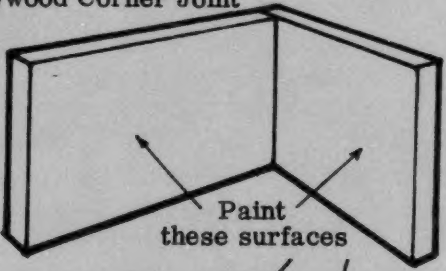
- Can of paint (water or oil base)
- Empy can
- Flat brush
- Block of lumber
- Plywood corner joint
- Mixing paddle or mixer used with electric drill
- Proper thinning and cleaning material

Directions: Position the block of wood and plywood corner joint on a suitable surface for painting. Thoroughly read the directions on the paint can.



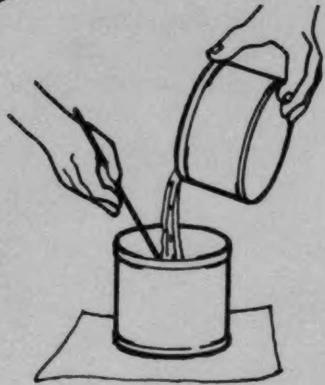
Paint edges and top surface

Plywood Corner Joint



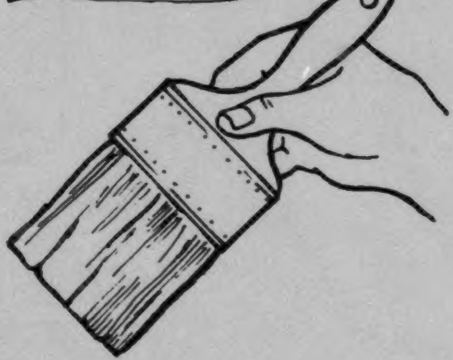
Procedure:

A. Mix the paint by pouring the thin material (liquid) off the pigment and stirring the pigment with a paddle as the thin material is re-added to the pigment. Continue to stir the paint until the pigment and liquid or vehicle are thoroughly mixed.

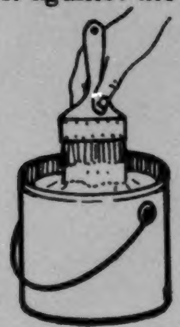


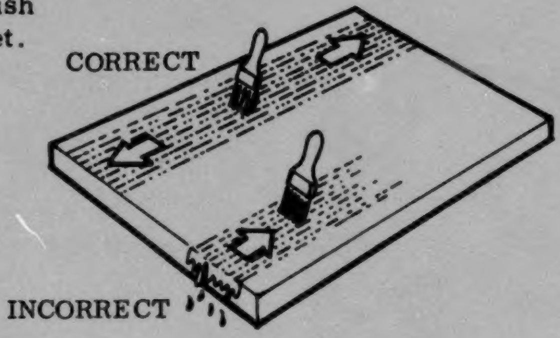
B. A mixer inserted in the chuck of an electric drill will aid in mixing. If the paint requires thinning, follow the directions on the container. If the paint has a skin formed on top, remove the skin before mixing.

C. Select the proper size and type of brush. Hold the brush by placing the thumb over the small part of the handle with the fingers resting on the ferrule (large part of the brush).



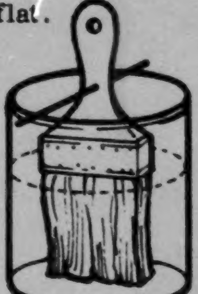
D. Dip one-fourth to one-third of the brush bristles into the paint. Remove excess paint from the finger side of the brush by wiping it against the paint bucket.





E. Properly prepare the surface to be painted. Apply paint to the surface by bringing the brush against the surface very lightly, then make long sweeping strokes in the same direction to form a thin uniform film of paint. The brush should be lifted gradually at both ends of the stroke to form a thin film at the beginning and end. Try to make the stroke the length of the surface when covering a small area. Large areas require extra brushing where the paint overlaps. When painting wood surfaces, it is advisable to make strokes with the grain if the surface is smooth.

F. Clean and store the brush properly. The following steps are recommended:
1. Remove the excess paint from a brush by either brushing it out or wiping it from the bristles.
2. Select the correct solvent and pour enough in the wash container to cover the bristles. Work or move the brush around by the handle to remove most of the paint, then use the fingers to open the brush hair and work the paint out of the bristles to the handle.
3. Wipe the brush dry with a paper towel or rag, then use a detergent with water and work it into the hairs. Wash thoroughly and rinse. Dry the brush again and either hang it on a wire in a bucket or wrap in paper and lay flat.



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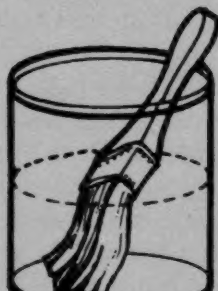

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STUDENT ____________________ SCHOOL ______________

AGRICULTURAL MECHANICS L-1a DATE ______________

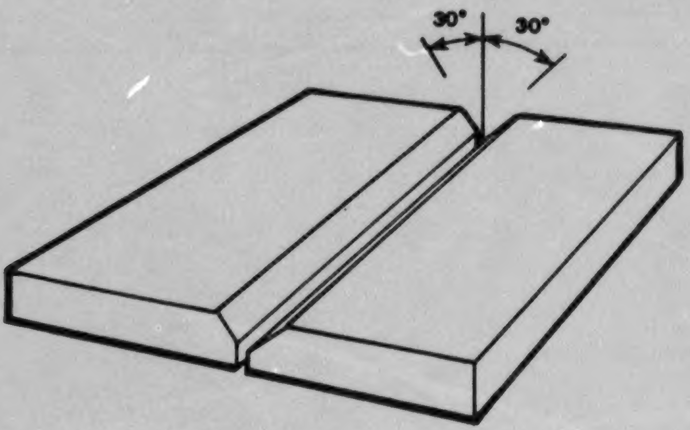
SKILL SHEET - ARC WELDING SINGLE V - BUTT WELD

Materials Needed:

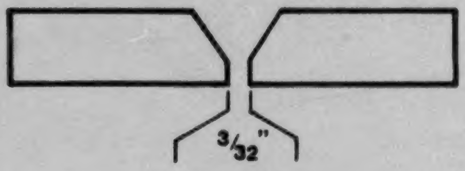
Welder
Gloves, helmet, and safety glasses
Chipping hammer and wire brush
Steel tape and pliers
Grinder
Mild Steel- two pieces 2" x 5" x 1/4"
E 6011 electrodes (1/8 or 5/32)

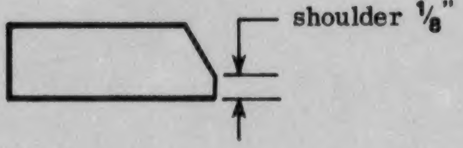
Procedure and Illustration:

A. Clean the metal.
B. Bevel the edge of each piece at a 30-degree angle, and place the two pieces parallel to each other. (Leave a 1/8" shoulder on bottom).



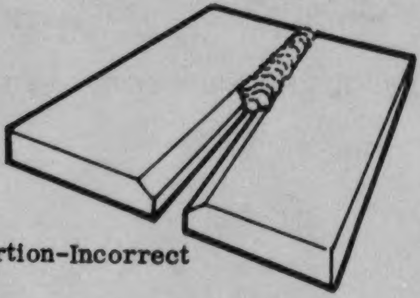
C. Space the metal apart approximately 3/32".

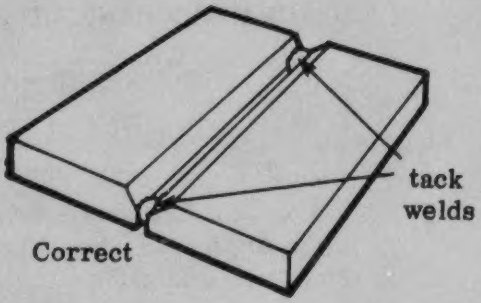




D. Adjust the welder to approximately 90 amperes.

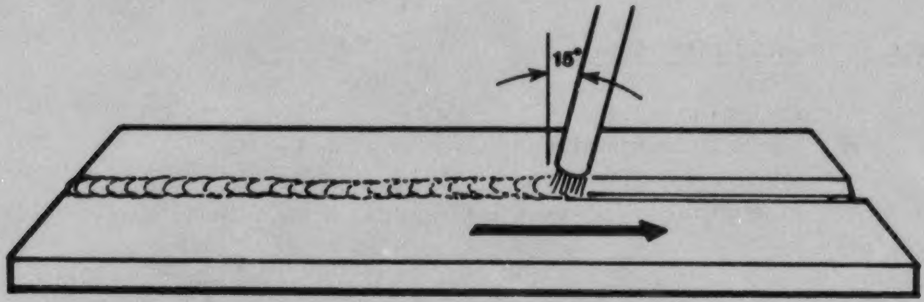
E. Tack weld both ends to prevent distortion.


Distortion-Incorrect



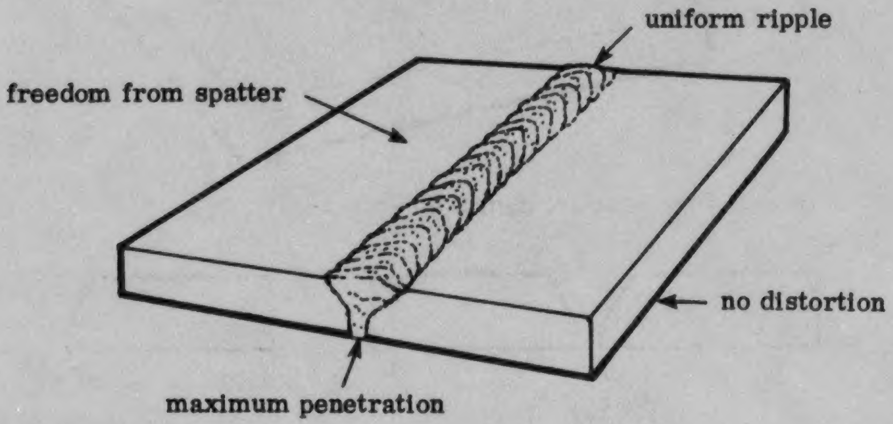
Correct

F. Position the metal for welding and run a single pass tilting the electrode 15 degrees from vertical in the direction of travel.



G. Chip the slag and brush the weld clean.

H. Check for uniformity and quality.


uniform ripple
freedom from spatter
no distortion
maximum penetration

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AGRICULTURAL MECHANICS L-1b DATE ______________

SKILL SHEET - ARC WELDING, T - FILLET WELD

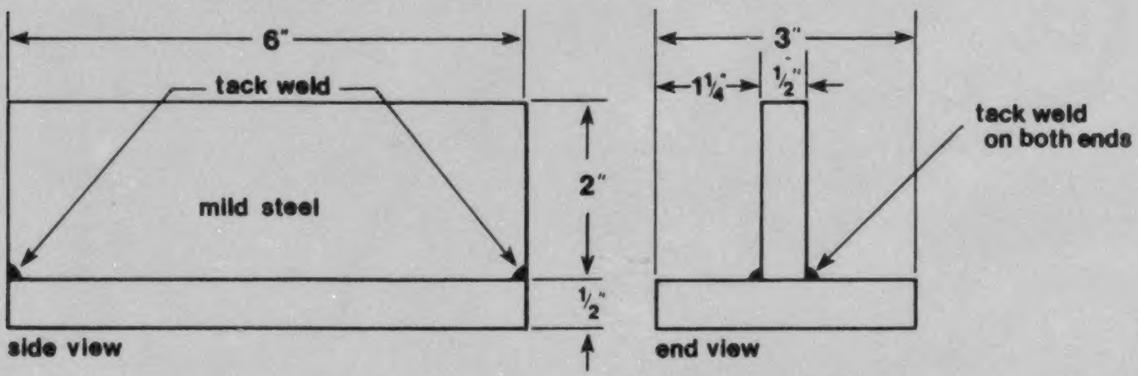
Materials Needed:

- Welder
- Gloves, helmet, and safety glasses
- Chipping hammer and wire brush
- Steel tape and pliers
- Mild steel - 1 piece 3" x6" x 1/2"
  1 piece 2" x 6" x 1/2"
- E 6013 electrodes (5/32)
- Grinder

Procedure and Illustration:

A. Clean the metal.

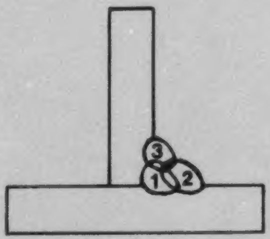
B. Position the plates and tack weld them in alignment.


6"
tack weld
mild steel
2"
½"
side view
3"
1¼"
½"
tack weld on both ends
end view

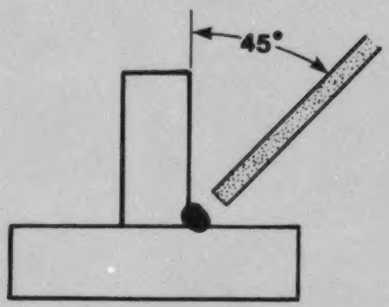
C. Adjust the welder to 100-120 amperes and begin the multiple pass welding procedure.

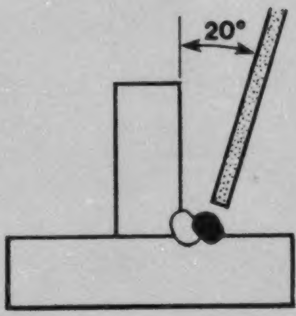
D. Chip, clean, and inspect each pass upon completion.

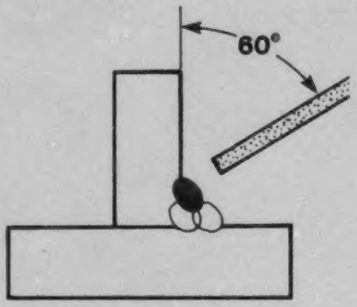
E. Three passes should be made as illustrated here, making sure each pass fuses correctly.



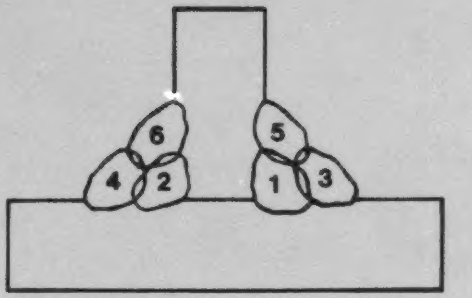
F. The electrode position is shown below for the three passes in completing the weld.



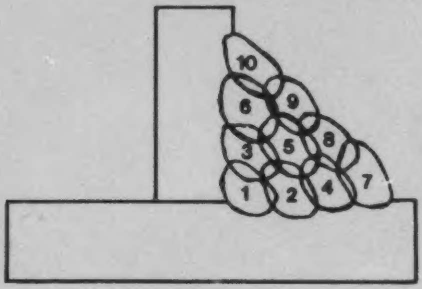


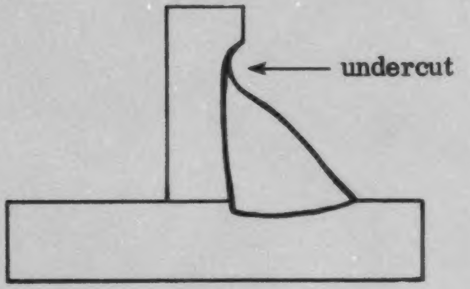


G. Distortion can be kept to a minimum by using the six pass procedure.

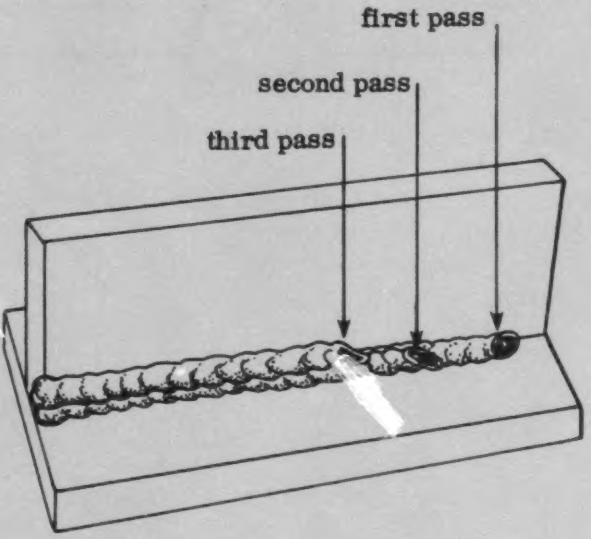


H. Many more passes can be made if necessary. Care should always be taken to prevent undercutting.


10
6
9
3
5
8
1
2
4
7



I. Shown below is the side view of the partially completed three pass procedure. Note the fusion and uniformity of each pass.


first pass
second pass
third pass

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STUDENT ________________ SCHOOL ____________

AGRICULTURAL MECHANICS L-1c DATE ____________

SKILL SHEET - ARC WELDING, OPEN CORNER JOINT WELD

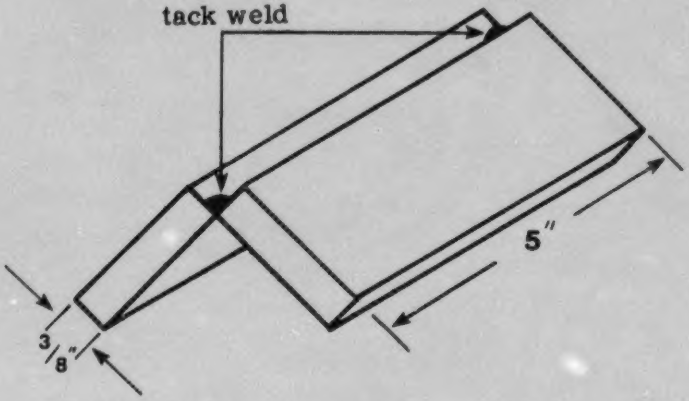
Materials Needed:

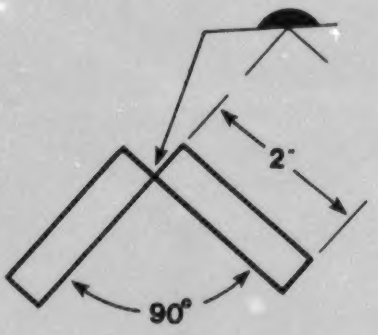
- Welder
- Gloves, helmet, and safety glasses
- Chipping hammer and wire brush
- Steel tape and pliers
- Grinder
- Mild steel - 2 pieces 2" x 5" x 3/8"
- E 6011 electrodes (1/8 or 5/32)

Procedure and Illustration:

A. Clean the metal.

B. Position the plates and tack weld them in alignment.

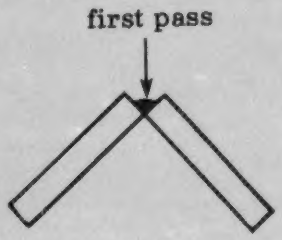


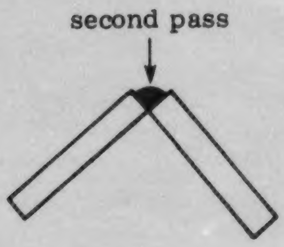


C. Adjust the welder to 80-100 amperes and make the first pass.

D. Clean and inspect the weld.

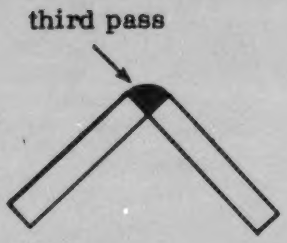
E. Make the second pass by using a weave pattern. Weave the electrode from side to side, stopping on each edge until the edge almost melts.



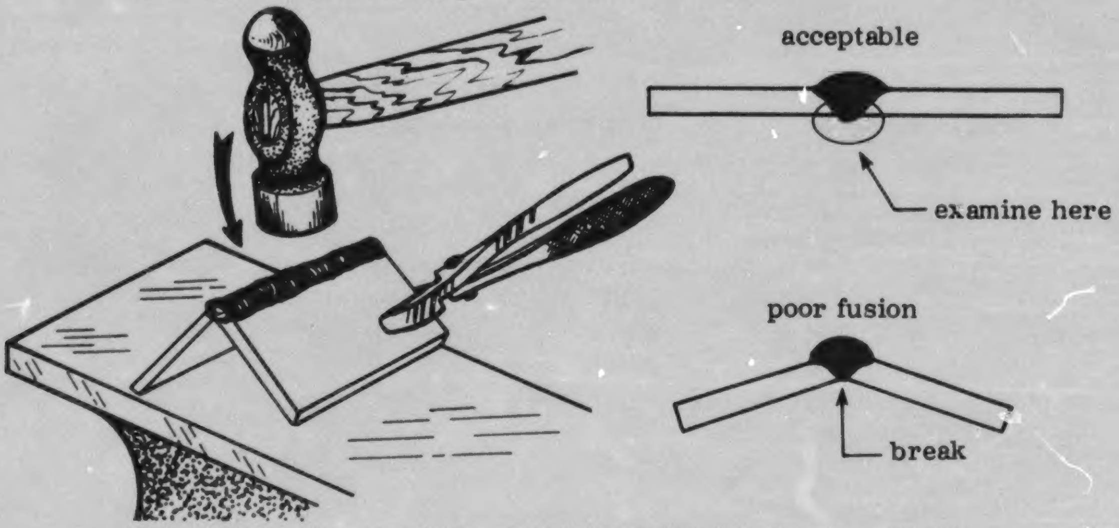


F. Clean and inspect the weld.

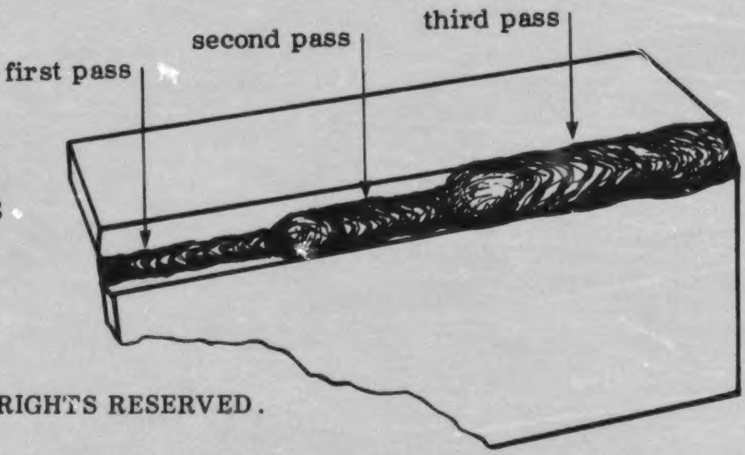
G. Make a third pass if necessary to complete the joint. Take precautions not to overhang the edges of the plate.



H. Clean and inspect the weld. The weld can be tested by placing the completed assembly on an anvil and hammering it flat in order to examine root fusion and penetration.


acceptable
examine here
poor fusion
break

I. Shown below is a partially completed joint showing how the three passes are deposited.


third pass
second pass
first pass

CORNER JOINT WELDS

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AGRICULTURAL MECHANICS L-1d DATE ____________

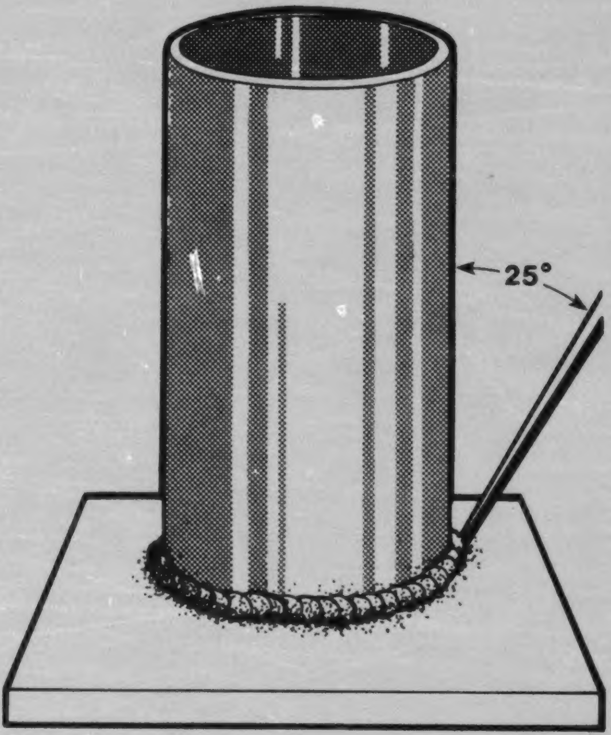
SKILL SHEET - ARC WELDING, CONTINUOUS BEAD PIPE T- FILLET WELD

Materials Needed:

- Welder
- Gloves, helmet, and safety glasses
- Chipping hammer and wire brush
- Steel tape and pliers
- Grinder
- Mild steel - 1 piece 4" x 4" x 1/4"
- Black pipe - 1 piece 4" long by 2" in diameter
- E 6011 electrodes (1/8)

Procedure and Illustration:

A. Clean the metal.
B. Position the pipe in the center of the plate.
C. Tack weld the pipe to the plate in four places.
D. Adjust the welder to 90 amperes and begin the weld, holding the electrode 25° from the pipe in order to keep excessive heat off the pipe and concentrated on the plate.
E. Complete the weld without breaking the arc.
F. Clean and inspect the weld.
G. Test for pin holes by filling with water.



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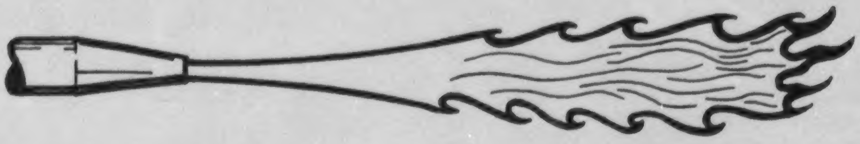
AGRICULTURAL MECHANICS L-3a DATE ______________

SKILL SHEET- OXYACETYLENE, FLAME ADJUSTMENT, TURNING ON AND TURNING OFF THE UNIT

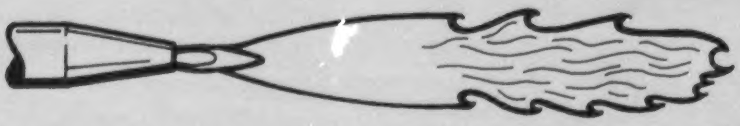
Materials Needed:

Oxyacetylene rig checked for leaks
Safety goggles, gloves, and proper clothing
Flint lighter
Manufacturer's specifications and data sheets

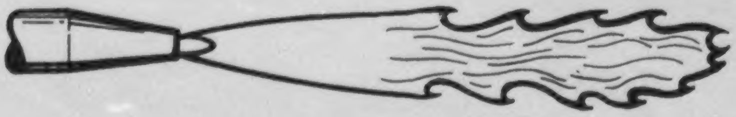
Acetylene Flame
(no oxygen)



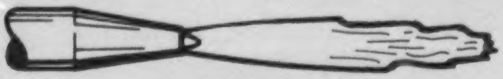
Carburizing Flame
(excess acetylene)



Neutral Flame
(rounded cone, quiet sound, equal oxygen and acetylene)



Oxidizing Flame
(pointed cone, hissing sound due to excessive oxygen)



Procedure For Turning On The Oxyacetylene Rig:

A. Valves on the torch body should be closed.
B. The adjusting screws on the regulators must be loose.
C. Turn on acetylene cylinder valve 1/4 - 1/2 turn; if wheel type, open all the way.
D. Tighten the regulator adjusting screw to the desired working pressure.
E. Open the oxygen cylinder valve all the way.
F. Tighten the regulator adjusting screw to the desired working pressure.
G. If the cutting attachment is being used, open the torch body oxygen valve all the way.
H. Crack the acetylene valve and light. Blow the flame off the tip and slowly adjust it back.

I. Adjust to a neutral flame with the oxygen valve. The oxygen pressure can be 3-10 times higher than the acetylene pressure when cutting. Never exceed 15 pounds pressure per square inch on acetylene. When welding, the ratio of oxygen to acetylene is approximately 1:1. Oxygen and acetylene settings will vary depending on the attachment tip and thickness of metal to cut or weld.

Procedure For Turning Off The Oxyacetylene Rig:

A. Turn off the acetylene at the torch body (the flame will go out and the oxygen will blow out the carbon).
B. Turn off the oxygen at the torch.
C. Turn off the acetylene cylinder valve.
D. Bleed the acetylene hose and regulators, then close the torch valve (both gauges will drop to zero).
E. Screw out the acetylene regulator adjusting screw until loose.
F. Turn off the oxygen cylinder valve.
G. Bleed the oxygen hose and regulators and close the torch valve (both gauges will drop to zero).
H. Screw out the oxygen regulator adjusting screw until loose.
I. Re-check the valve and roll up the hose. If rig is not to be used for some time, remove the regulators and put the safety caps back on the cylinders.

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AGRICULTURAL MECHANICS L-3b DATE ______________

SKILL SHEET - OXYACETYLENE, CUTTING A SQUARE CUT

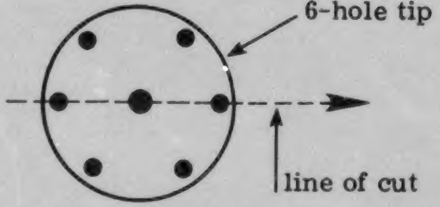
Materials Needed:

- Oxyacetylene unit checked for leaks
- Flint lighter and tip cleaner
- Gloves, safety goggles, and proper clothing
- Soapstone, straight edge, and pliers
- Cutting table and container to catch slag
- Container of water to cool metal
- Mild steel plate 4 " x 8" x 3/8"

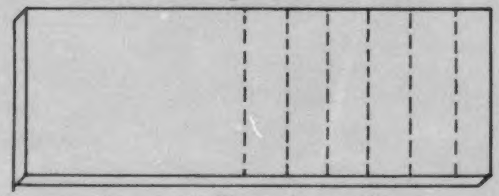
Procedure and Illustration:

A. Use the tip cleaner and properly clean the orifices.

B. Align the orifices in a manner to permit one preheat to lead the cut and another to follow the cut.



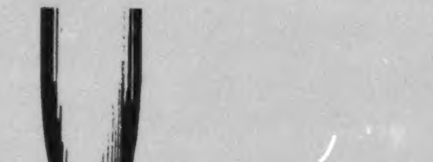
C. Use soapstone and straight edge to mark several parallel lines on the plate to be cut.



save the cut-off portions for future welding exercises

D. Adjust the working pressures to manufacturer's specifications (approximately 4 psi acetylene and 30 psi oxygen).

E. Light the torch and adjust to a neutral flame with the cutting lever depressed.



F. Assume a relaxed position and keep the hoses behind the operator.

G. Steady the torch by resting it on one hand, and press the oxygen lever and move with the other hand.

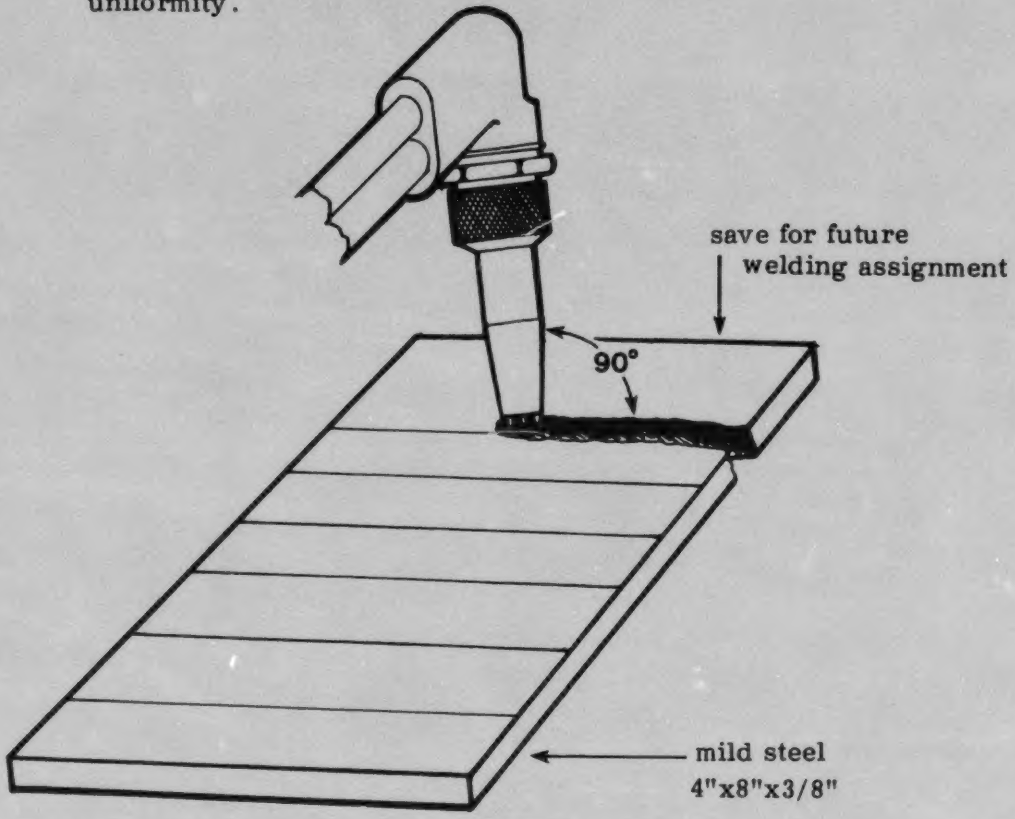
H. Hold the preheat flame with the tip of the inner cone 1/8" above the edge of the plate until a molten red spot appears.

I. Depress the oxygen cutting lever and move across the plate at the proper speed. The inner cone should be 1/8" to 1/4" above the plate to prevent molten metal from damaging the tip.

J. Keep the torch tip perpendicular to the plate, and in this case, cutting 3/8" steel, the torch tip should be perpendicular to the line of cut (90°).

K. Use the pliers to hold hot metal while cooling it in water.

L. Inspect each cut for uniformity.



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Student ________________ **School** ________________

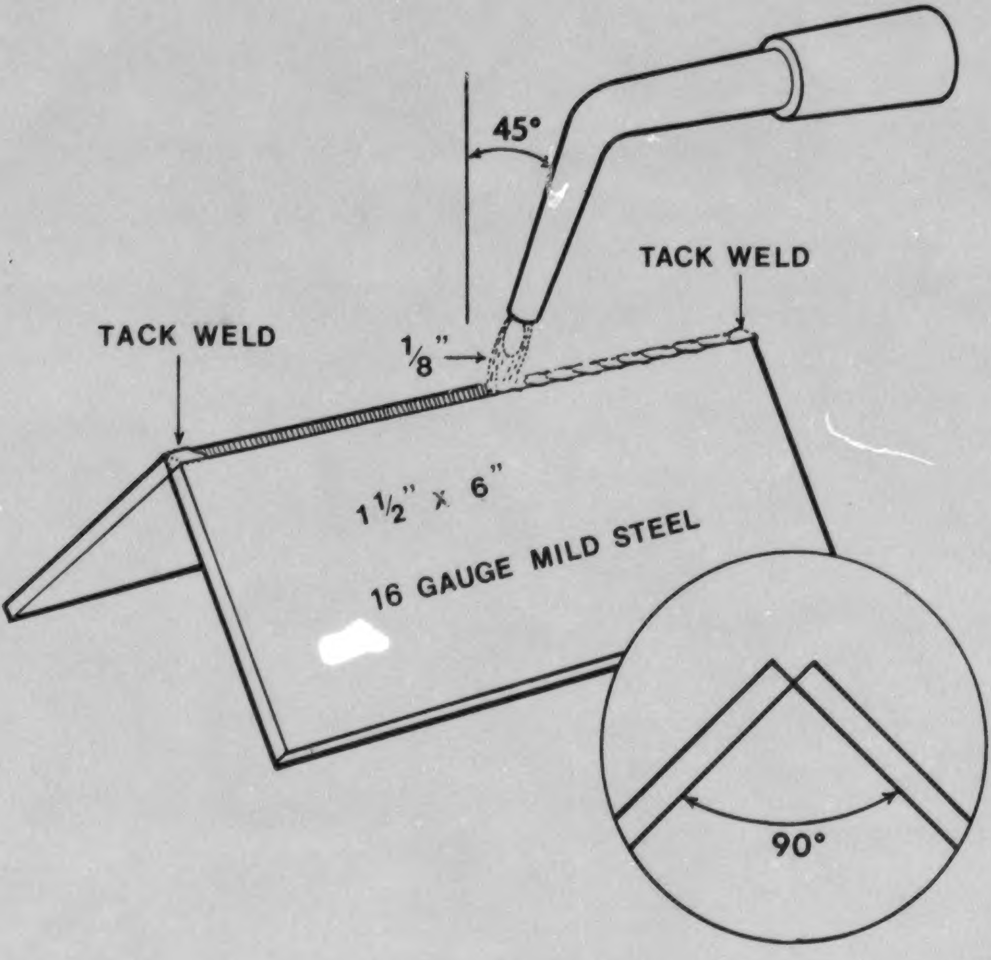
Agricultural Mechanics L-3c **Date** ________________

SKILL SHEET - CORNER FUSION WELD WITHOUT FILLER ROD

I. Materials Needed:

Mild steel - 2 pieces 16 gauge 1 1/2" x 6"
Oxyacetylene welding unit and safety equipment
Welding tip (sized according to manufacturer's specifications)
Pliers, wire brush, flint lighter, and fire brick

II. Illustration of Corner Weld:


45°
TACK WELD
TACK WELD
1/8"
1 1/2" x 6"
16 GAUGE MILD STEEL
90°

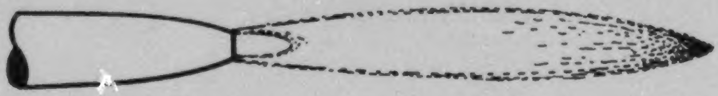
III. Procedure:

A. Clean the metal and position the two pieces for welding.

B. Correctly set up the oxyacetylene unit, test for leaks, and clean the tip.

C. Turn on the oxyacetylene unit and adjust the working pressure according to the manufacturer's specifications.

D. Light the torch and adjust to a neutral flame.



E. Tack weld the metal at both ends.

F. Hold flame inner cone about 1/8" from the joint to be welded.

G. Begin travel after the molten puddle is formed.

H. Hold the tip vertically at a 45-degree angle from the direction of travel.

I. Slowly advance the puddle by weaving the flame from side to side across the joint to be welded.

J. Complete the corner weld and check for uniformity.

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AGRICULTURAL MECHANICS M-1a DATE ____________________

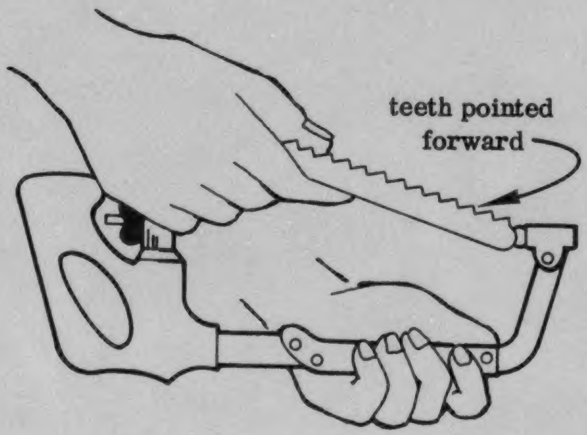
SKILL SHEET - USING THE HAND HACKSAW

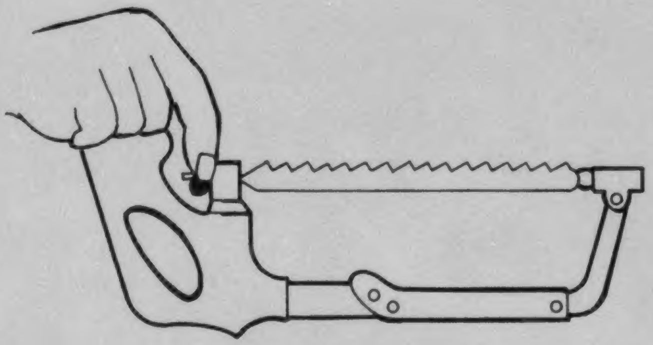
Materials Needed:

Adjustable hacksaw frame
Assortment of blades
Work table, vise, and clamps
Scrap lumber blocks
Plate metal and sheet metal
Try square and marking device

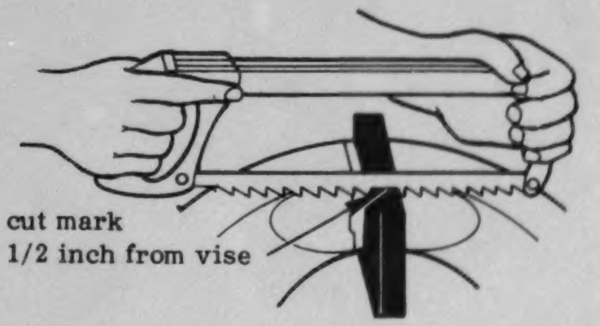
Procedure and Illustration:

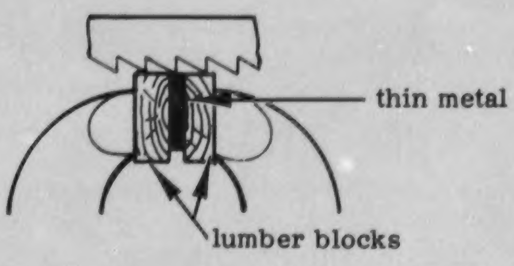
A. Select a saw blade that will allow 2-3 teeth to be in contact with the metal surface as it is being cut.
B. Insert the blade in the frame so that the teeth point forward away from the handle.
C. Tighten the blade in the frame. Proper blade tension will prevent buckling.
D. Use the hacksaw for a short time and retighten the blade. A loose blade will break easily.





E. Clamp the metal in a vise with the cutting mark about 1/2 inch from the side of the jaws. When cutting extremely thin stock, it is desirable to clamp pieces of lumber on the sides of the metal to prevent the teeth from straddling the metal.





F. Hold the saw with both hands and start the cut by pulling it toward the body (backward stroke). The kerf may be started by filing a notch in the metal. As the saw is pulled backward a small amount of pressure should be applied.

G. Do not apply pressure on the backward stroke after the saw begins cutting.

H. Apply the correct amount of pressure as the saw is pushed forward. Angle the blade for making thin metal cuts.

I. Steady strokes from 40 to 50 per minute are considered the correct speed for most sawing jobs. Strokes should be long and even, using the entire length of the blade.

J. If the cut cannot be made with the same blade, turn the piece of metal over and start from the other side, or start a new cut. If a new blade is placed in an old cut, it will wedge and the set will be ruined after a few strokes.

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AGRICULTURAL MECHANICS M-1b DATE ____________________

SKILL SHEET - COLD CUTTING THIN FLAT METAL

Materials Needed:

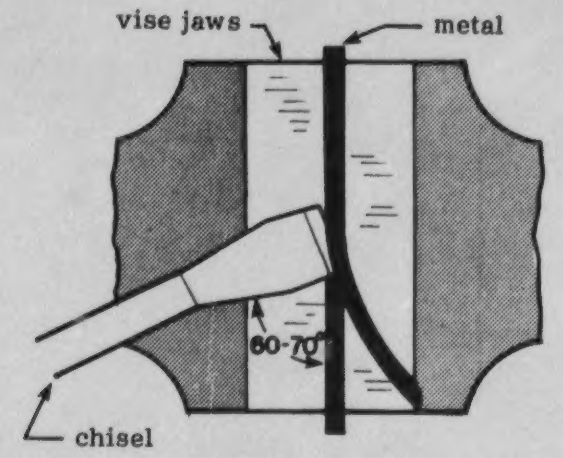
- Try square and marking device
- Flat strip of metal less than 3/16 inch thick
- Chisel
- Machinist's hammer
- Vise, work table, and anvil
- Safety glasses

Procedure and Illustration:

A. Mark the metal to be cut.

B. Clamp the metal in the vise with the cutting line even with the top of the vise jaws.

C. Hold the chisel at a 60° to 70° angle with the metal.



D. Place the cutting edge of the chisel against one end of the metal with the bottom face of the bevel flat on top of the vise jaws.

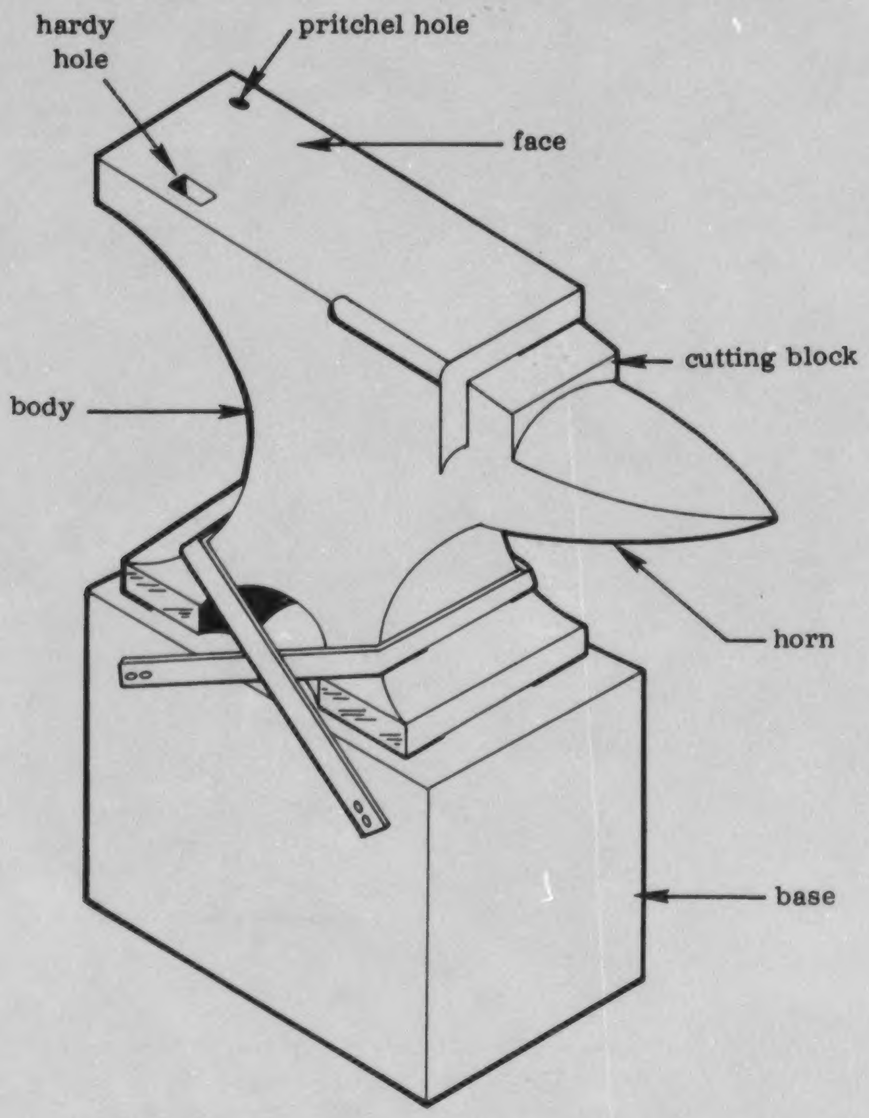
E. Strike the chisel with the hammer, and move it along the cut, shearing off the metal even with the vise jaws.

F. To cut the metal on an anvil, place the metal flat on the cutting block of the anvil with the marked side up.

G. Cut the metal about halfway through along the mark.

H. Bend the metal back and forth over the edge of the anvil until it breaks.

I. Thicker metal may be sheared in the same manner by cutting on both sides before it is broken.


hardy hole
pritchel hole
face
cutting block
body
horn
base

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AGRICULTURAL MECHANICS M-1c DATE ______________

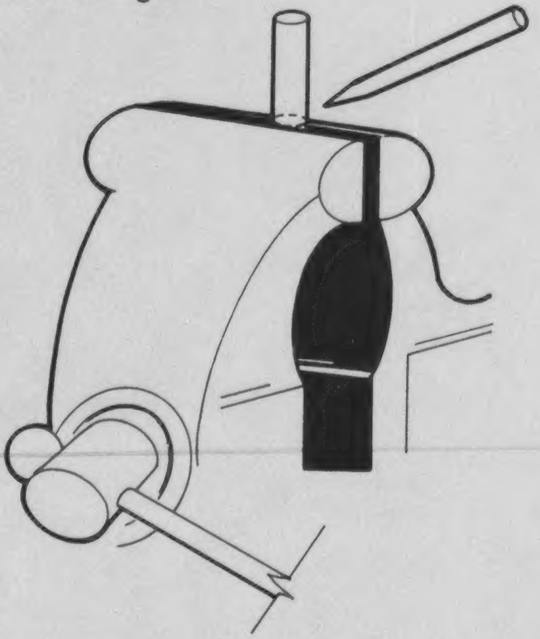
SKILL SHEET - COLD CUTTING ROUND METAL

Materials Needed:

Vise, work bench, and anvil	Safety glasses
Flat chisel	1/4" - 5/8" round metal
Machinist's hammer	Measuring and marking device

Procedure and Illustration:

A. Measure and mark the stock at the desired length.
B. Secure the metal in a vise with the cutting mark even with the top of the vise jaws.
C. Cut a notch all the way around the metal with a cold chisel. The notch should be made about one-third of the distance through the stock.



D. Bend the stock back and forth across the vise until it breaks.
E. If the metal is to be cut on an anvil, place it flat on the cutting block of the anvil. Set the cold chisel on the mark and cut a notch one-third of the way through.
F. Turn the metal over and cut a notch opposite the first one in the same manner.
G. Bend the stock over the edge of the anvil until it breaks.

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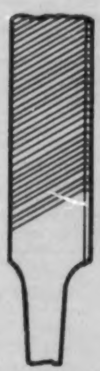
AGRICULTURAL MECHANICS M-1d DATE ____________________

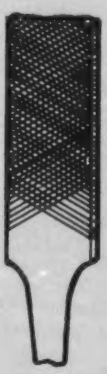
SKILL SHEET - USING THE FILE

Materials Needed:

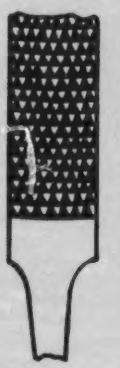
- Assortment of files and handles
- Metal stock for filing
- Vise and work table
- Straight edge and try square
- File card and brush
- Classroom chalk



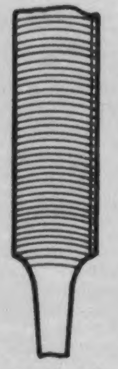
single cut



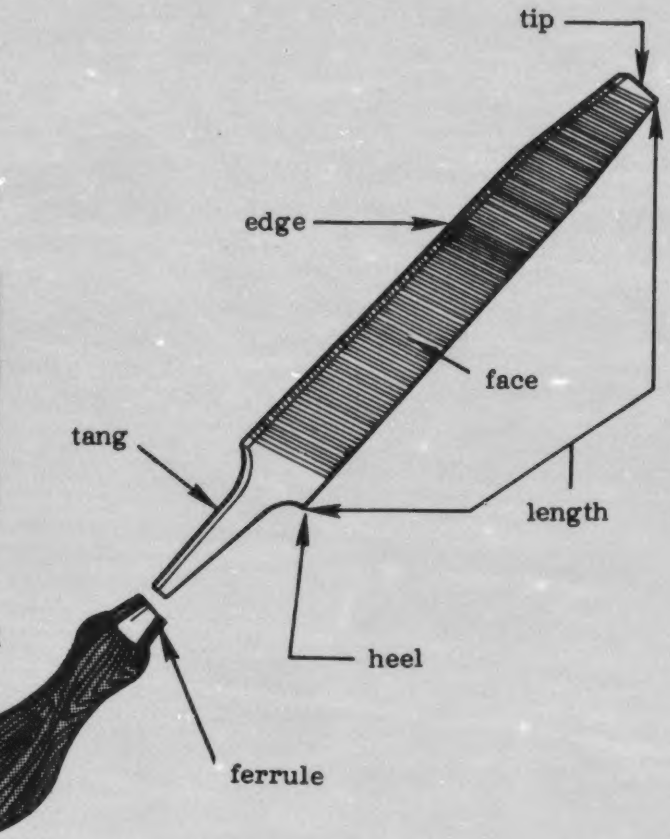
double cut



rasp cut



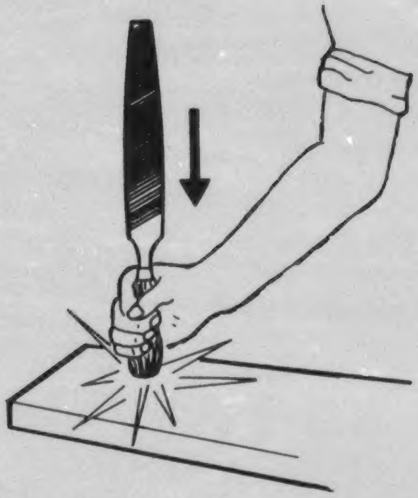
curved tooth



Procedure and Illustration:

A. Select the proper file for the work to be done.

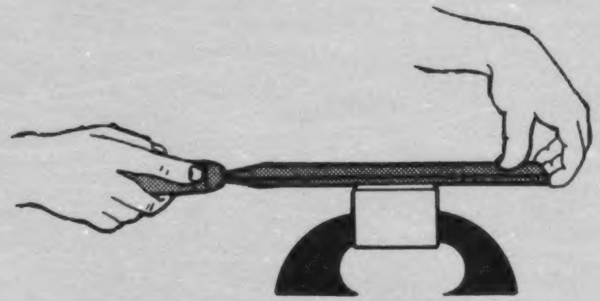
B. Insert the tang into the file handle and tighten it by tapping the end of the handle on the workbench unless the handle is threaded.



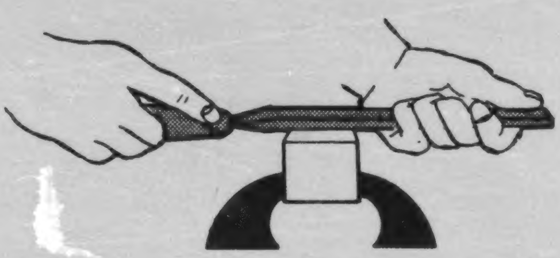
C. Secure the metal to be filed in a vise to prevent vibration. The top of the vise should be on about the same level as the elbow.

D. Grasp the file handle with one hand, holding the tip with the thumb and fingers of the other. Methods of holding will vary depending on the work being done.

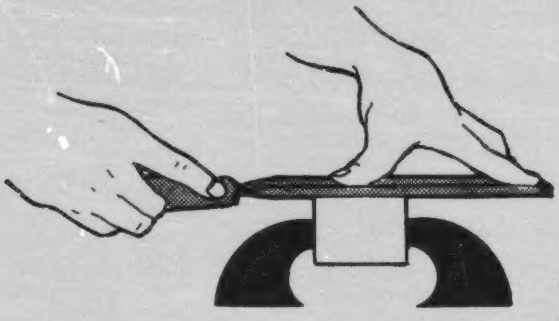
E. On the forward stroke, bear down with enough pressure to produce good cutting. On the return stroke, raise the file to avoid damaging the cutting edges. Control the file to prevent rocking and leaving an edge uneven.



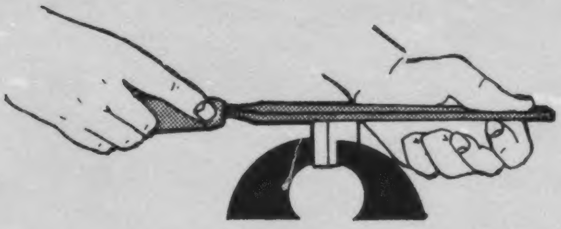
normal filing



heavy stock removal



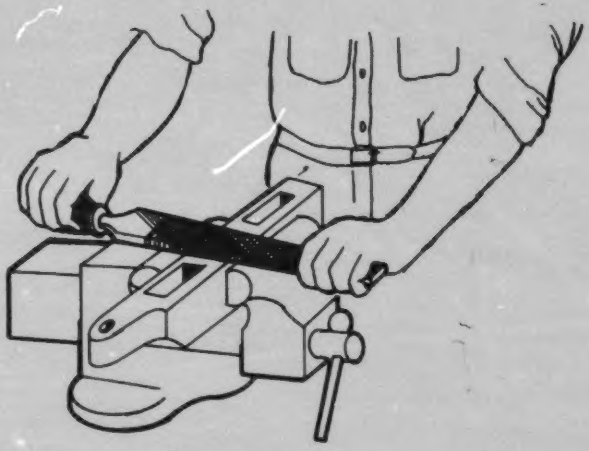
flat filing



precision work

F. The filing procedure should consist of about 30 strokes per minute. Each stroke should utilize the entire length of the file. Check the work often with the square or straightedge to see if it is straight or at the correct angle.

G. In instances where a smooth flat surface is to be filed, a different technique must be used.

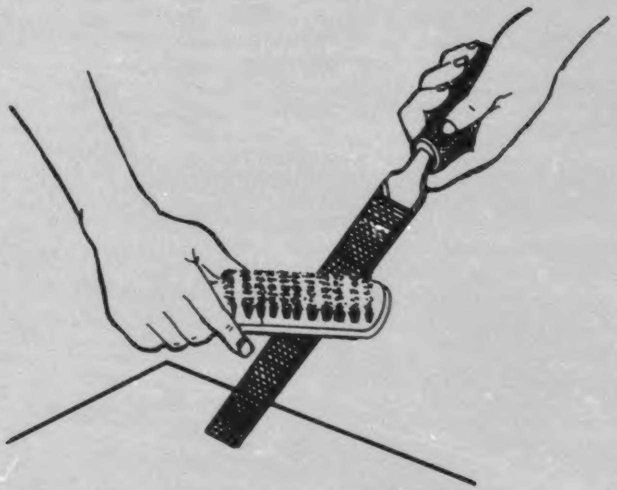


draw filing

H. Drawfiling is done by using a machinist's file and drawing the file crosswise over the work with a light pressure. Holding the file in this manner allows it to cut when moving in both directions.

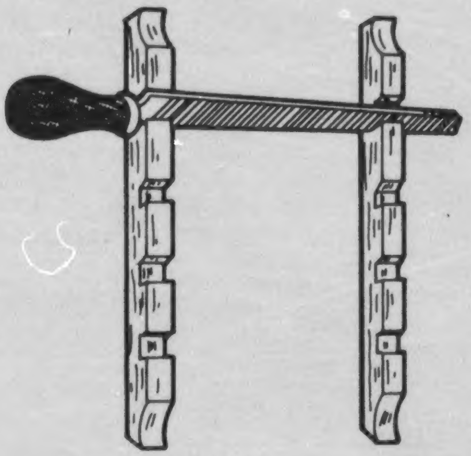
I. Tap the file lightly at the end of each stroke to clear the teeth of chips.

J. After completion of the job, clean the file with a file card and brush.



K. If chips are hard to remove, use classroom chalk rubbed into the file to prevent clogging at the next use.

L. To keep files sharp, see that their surfaces are protected when not in use. Do not throw files around on a bench or in a drawer. Keep files away from water to prevent rusting, and keep them from getting oily, as this prevents fast, clean cutting.



proper storage for files

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STUDENT ________________ SCHOOL __________

AGRICULTURAL MECHANICS M-2a DATE ___________

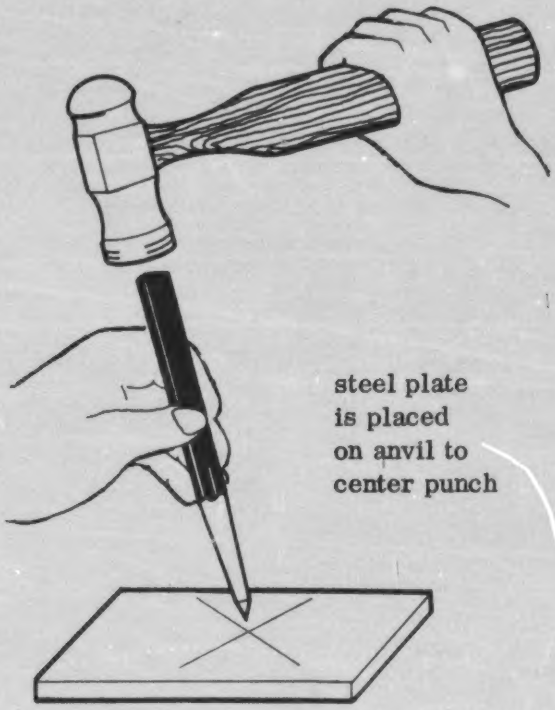
SKILL SHEET - DRILLING A HOLE WITH A DRILL PRESS

Materials Needed:

Mild steel plate 3 1/2" x 4 1/2" x 1/4"
Wooden block
Drill press, clamp, and twist drill
Center punch, ball peen hammer, and anvil
Cutting oil
Safety glasses, wire brush, scratch awl, and rule

Procedure and Illustration:

A. Use a rule to locate the center of the metal stock to be drilled, and use a scratch awl to mark an intersection at the center.
B. Place the metal on an anvil and mark the center of the hole with a center punch.

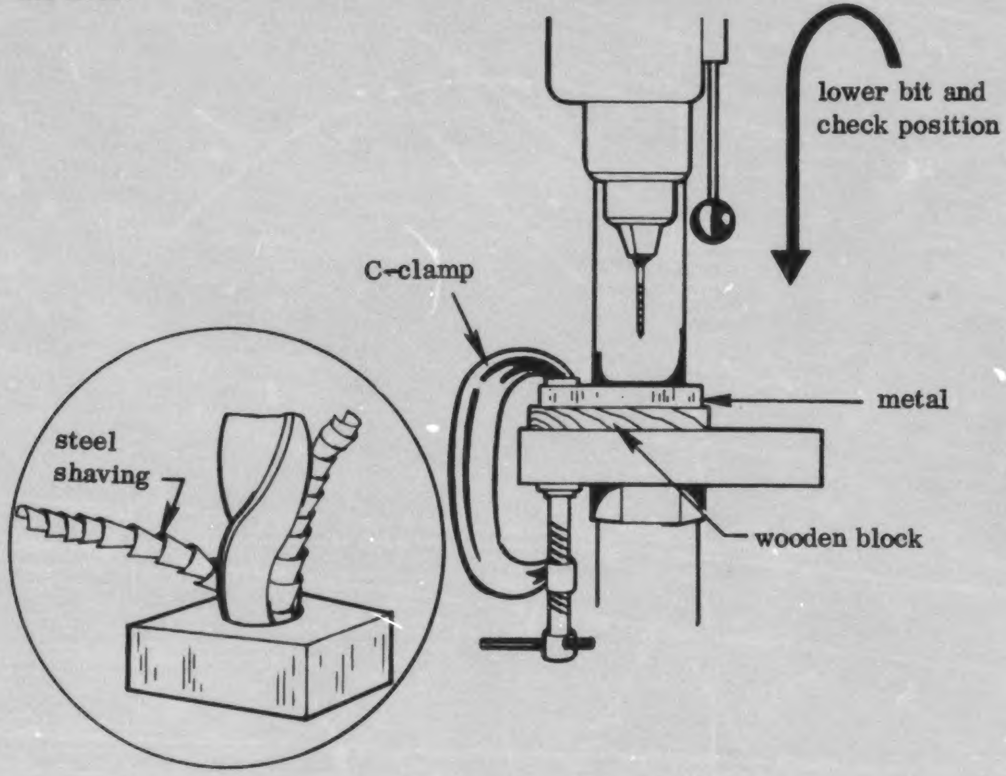


steel plate is placed on anvil to center punch

C. Properly tighten the twist drill in the drill press chuck.
D. Locate the drill press table in a manner that the hole to be drilled will be over the center hole in the table.
E. Set the drill depth stop to obtain proper hole depth.
F. Place the metal on a wooden block.
G. Use a C-clamp to secure the work to the table to prevent it from spinning.
H. Feed the drill bit down to the metal and start drilling.
I. Raise the drill bit to check for accuracy.

J. If the hole is properly centered, continue drilling. Use cutting oil on the drill bit two or three inches above the work.

K. In drilling mild steel, long curls of steel shavings should come from the hole.


lower bit and check position
C-clamp
metal
steel shaving
wooden block

L. Raise the drill bit from the work when proper depth is obtained. Turn off the machine.

M. Clean the shavings from the metal with a wire brush.

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AGRICULTURAL MECHANICS M-2b

DATE ____________

SKILL SHEET - THREADING A BOLT

Materials Needed:

Mild steel rod to be used as a bolt
Flat file and wire brush
Die assortment and die stock
Vise
Cutting oil or threading lubricant

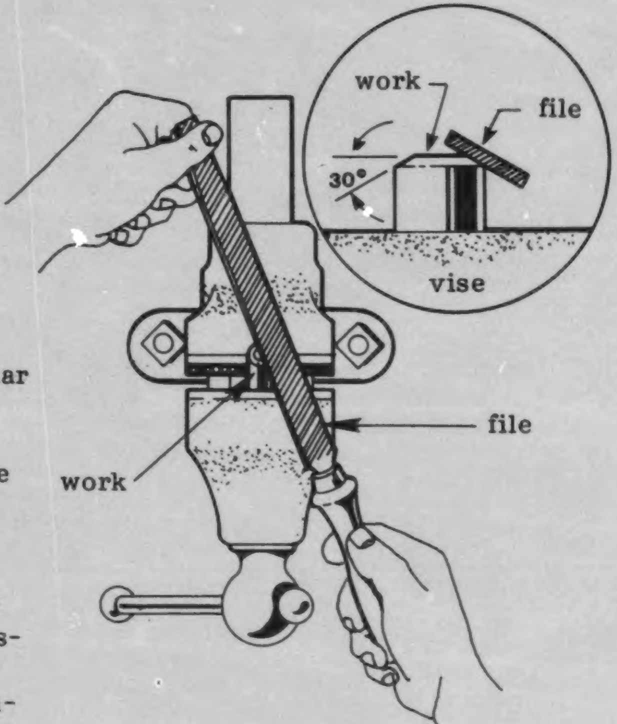
Procedure and Illustration:

A. Place the bolt or rod to be threaded in a vise and file a a 30-degree bevel on the end to be threaded. Be sure the bolt or rod is in a perpendicular position in the vise.

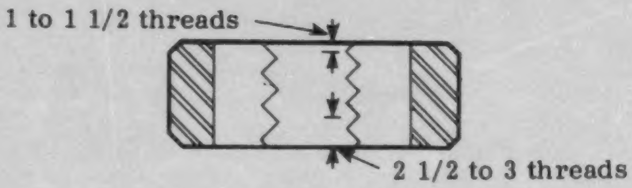
B. Select the proper size die and place it in the die stock. Place the bevel side of the die over the bevel on the bolt or rod.

C. Place the die squarely on the work. Turn the handle clockwise while applying down pressure.

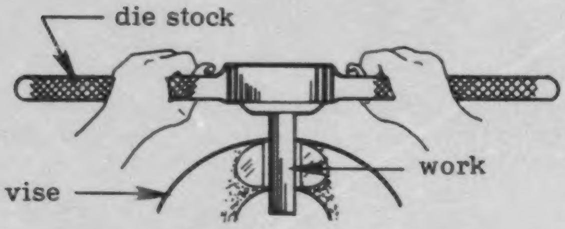
D. Apply cutting oil after one complete turn.



Beveling the End of Work Before Threading

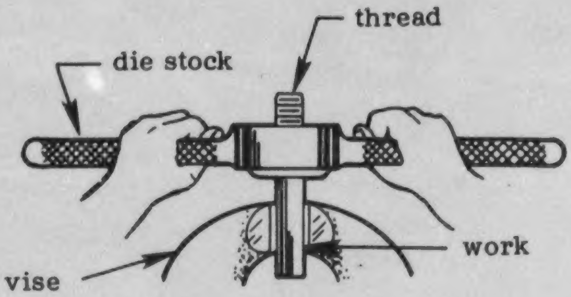


Bevel on Threading Die



Starting to Cut a Thread with a Stock and Die

E. Continue turning the die stock clockwise and add cutting oil after each turn. Down pressure is no longer needed because the die will draw itself on the work.



Cutting the Thread with The Stock and Die

F. Back up the die after the threading has started in order to break up the chips.
G. Back up one turn and go forward two turns until the desired thread length is obtained.
H. Remove the die by turning counterclockwise.
I. Brush and clean the threads and screw the desired nut on the bolt or rod.
J. Clean, oil, and properly store the die and die stock after the job is completed.

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AGRICULTURAL MECHANICS M-2c DATE ____________

SKILL SHEET - THREADING HOLE FOR 3/8" STUD WITH NATIONAL COARSE THREADS

Materials Needed:

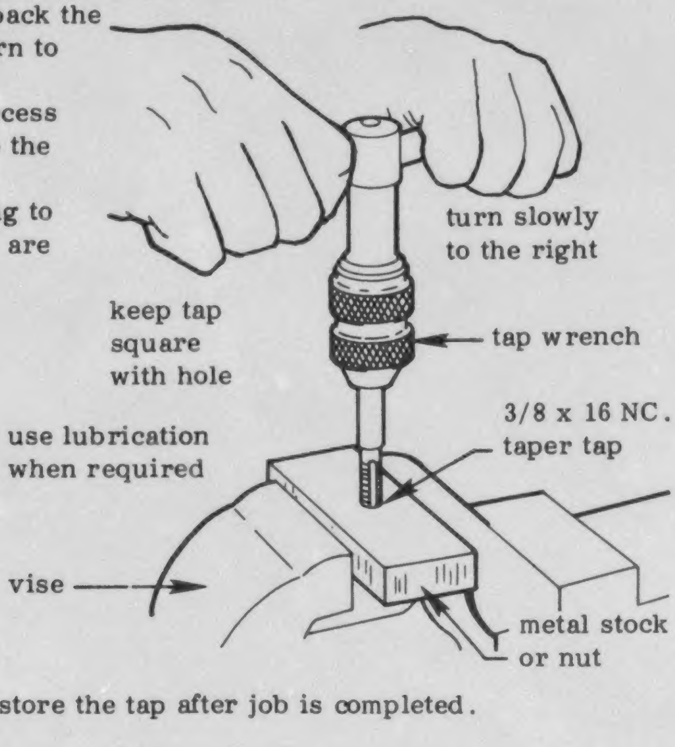
- Vise
- Tap assortment and tap wrench
- Metal stock or nut with 5/16" diameter hole drilled in it
- Cutting oil or tap lubricant
- Tap drill size chart

NOTE:

If the threaded hole is to be for a 3/8" stud with National Coarse threads, refer to the tap drill size chart and note that the drilled hole must be 5/16" in diameter. Also note there will be 16 threads per inch.

Procedure and Illustration:

A. Secure the metal stock or nut in a vise.
B. Use a 3/8 x 16 N. C. taper tap.
C. Start the tap carefully and use cutting oil or tap lubricant on the tap.
D. Turn the tap wrench one or two turns to the right, then back the tap out about one-half turn to break the chip.
E. Complete the tapping process by turning the wrench to the right.
F. Remove the tap by turning to the left when the threads are completed.


turn slowly to the right
keep tap square with hole
tap wrench
3/8 x 16 NC. taper tap
use lubrication when required
vise
metal stock or nut

G. Properly clean, oil, and store the tap after job is completed.

TAP DRILL SIZE CHART

Size of Bolt Thread	National Coarse (NC)		National Fine (NF)	
	Tap Drill Size	Threads Per Inch	Tap Drill Size	Threads Per Inch
3	47	48	45	56
10	25	24	5/32 or 21	32
1/4"	13/64 or 7	20	7/32 or 3	28
3/8"	5/16	16	21/64	24
1/2"	27/64	13	29/64	20
5/8"	17/32	11	37/64	18
3/4"	21/32	10	11/16	16

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AGRICULTURAL MECHANICS M-3a DATE ______________

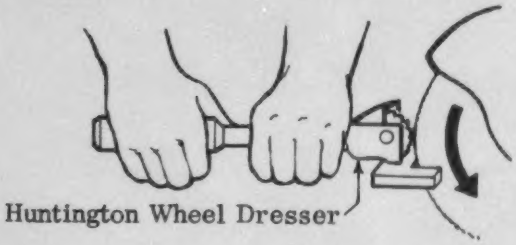
SKILL SHEET - DRESSING A GRINDING WHEEL

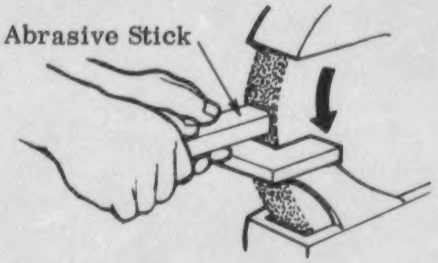
Materials Needed:

Grinder with tool rest (uneven, glazed wheels)
Safety glasses
Huntington wheel dresser
Abrasive stick
Combination Square

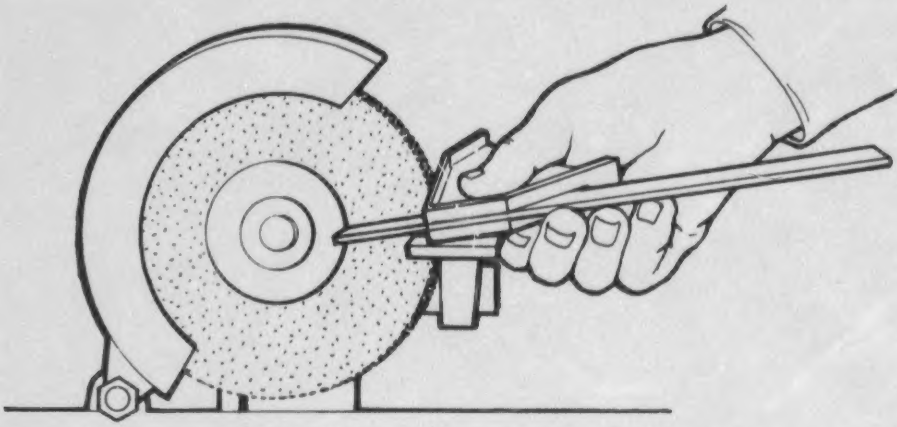
Procedure and Illustration:

A. Inspect the grinding wheel and determine the degree of glazing and the loss of squareness across the face.
B. Set the dressing tool on the grinder tool rest and press it firmly against the wheel. Apply enough pressure to prevent sparks.
C. Hold the dressing tool in the center of the wheel. Use a slight side to side movement across the wheel face if necessary.





D. Dress the grinder wheel with the tool until the edges are square with the sides.



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AGRICULTURAL MECHANICS M-3b

DATE ________________

SKILL SHEET - RESHAPING A COLD CHISEL

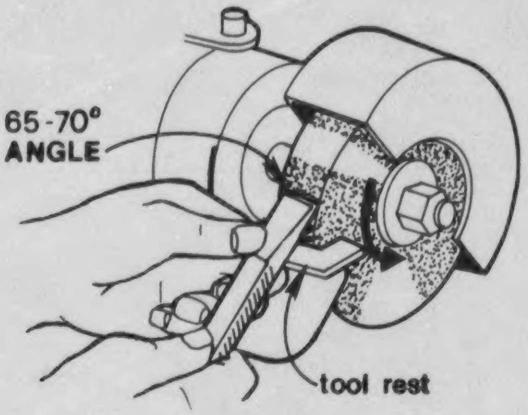
Materials Needed:

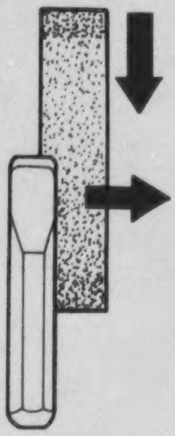
- Cold Chisel
- Grinder with adjustable tool rest
- Safety glasses
- Container of water

Procedure and Illustration:

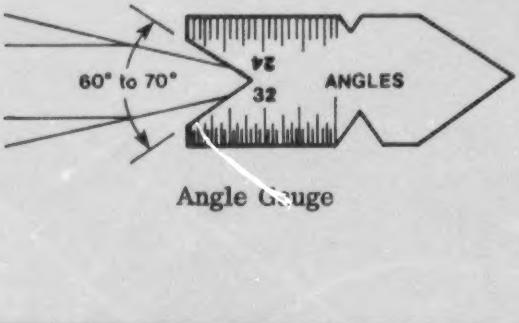
A. Joint the cutting edge by holding the chisel level on the tool rest while moving the point from side to side across the grinder wheel.

B. Position the chisel at a 65° to 70° angle with the handle pointing down. Move the point from side to side across the grinding wheel.

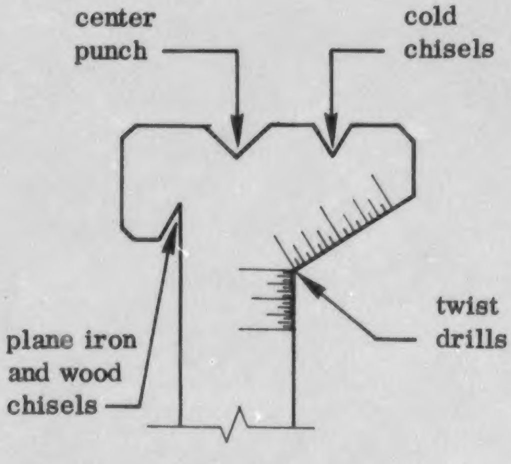

65-70°
ANGLE
tool rest



C. Grind both sides in the same manner. Check for the desired angle or bevel with an angle gauge or template.


60° to 70°
24
32
ANGLES

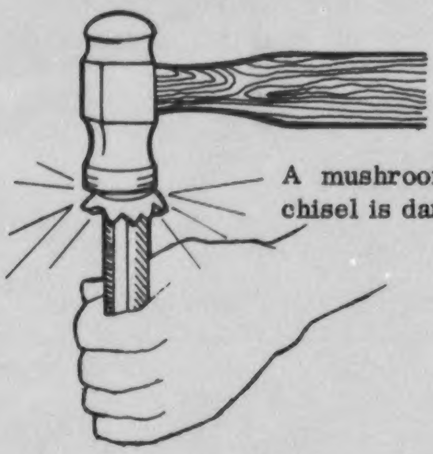
Angle Gauge

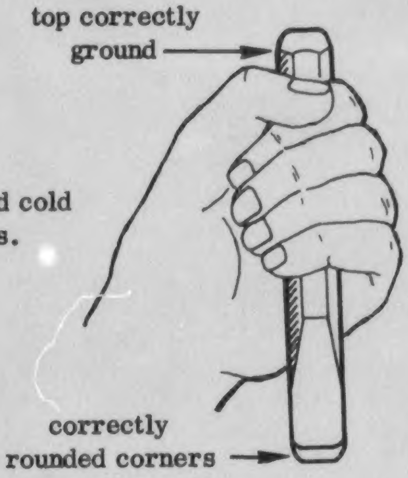

center punch
cold chisels
twist drills
plane iron and wood chisels

Template

D. Dip the point in water frequently to keep it from overheating.

E. Round the cutting edge corners slightly on large size chisels. If a mushroom head is formed on the chisel top, grind it off at the same time the chisel is being sharpened.


A mushroom head cold chisel is dangerous.


top correctly ground
correctly rounded corners

F. Honing the point may be necessary if a wire edge has been formed during the grinding process.

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AGRICULTURAL MECHANICS M-3c DATE ________________

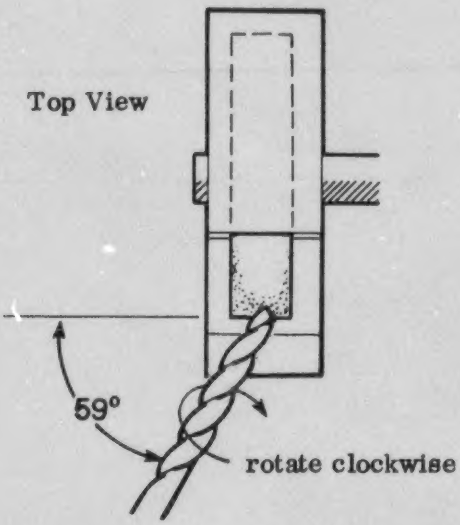
SKILL SHEET - FREE HAND SHARPENING A TWIST DRILL

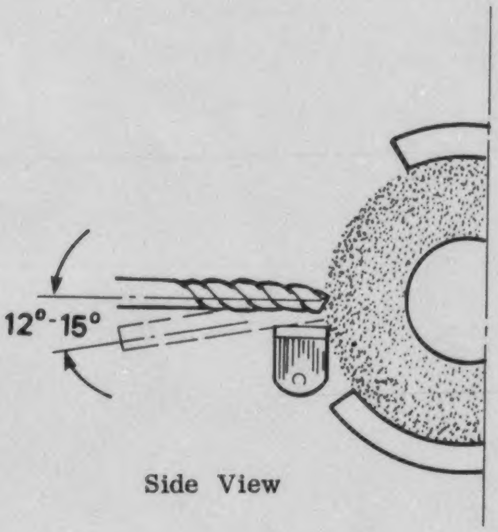
Materials Needed:

Dull twist drill
Safety glasses and angle template or gauge
Grinder with adjustable tool rest
Container of water

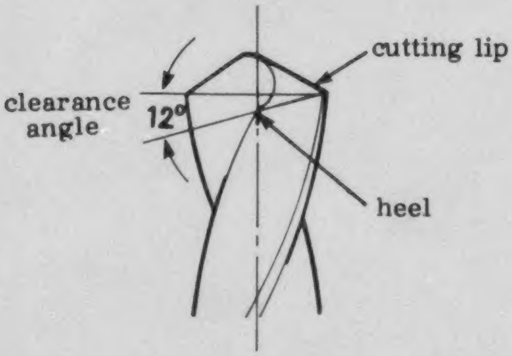
Procedure and Illustration:

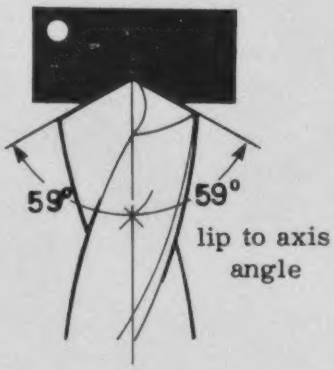
A. Place the drill point against the grinding wheel at approximately a 59° angle. (Rotate clockwise)


Top View
59°
rotate clockwise


12°-15°
Side View

B. Use one hand near the bit point and wheel; raise the bit cutting point and, at the same time, lower the shank slightly with the other hand during the cutting process. This action should form a clearance angle of about 12 degrees.


cutting lip
clearance angle
12°
heel

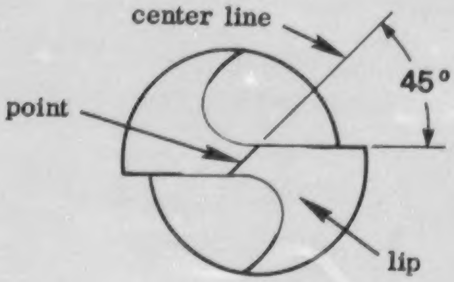

59°
59°
lip to axis angle

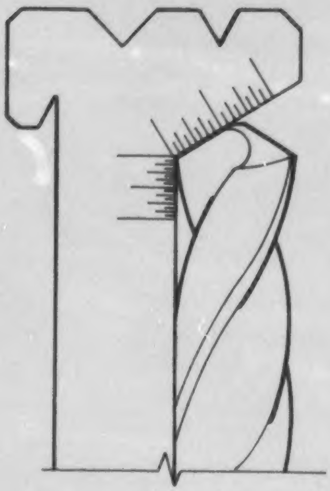
C. Dip the drill point in water at frequent intervals while it is being ground to keep it from overheating.

D. Rotate the drill and grind the other lip in the same manner.

E. Use a template to check the proper angle after every few stokes.

F. Determine the proper lip clearance by holding the drill bit in a horizontal position and level with the eye. The point or center line formed by grinding both lips should be 45 degrees to the cutting edge.





NOTE: Some shops are equipped with a drill sharpening attachment for the grinder to do more precision work. The free hand method of sharpening a drill bit is adequate in most cases if the proper procedure is followed.

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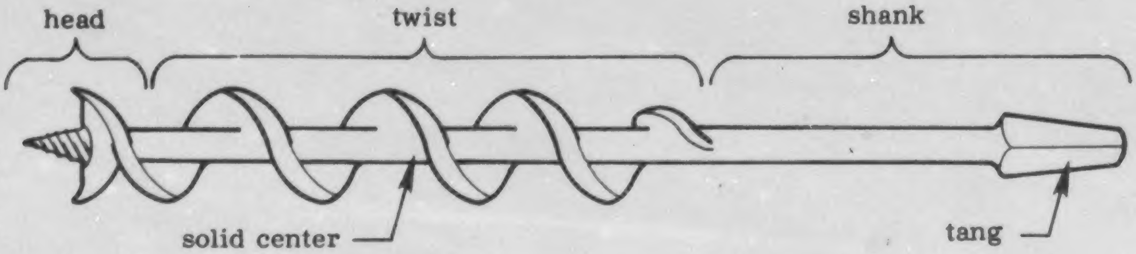
AGRICULTURAL MECHANICS M-3d DATE ________________

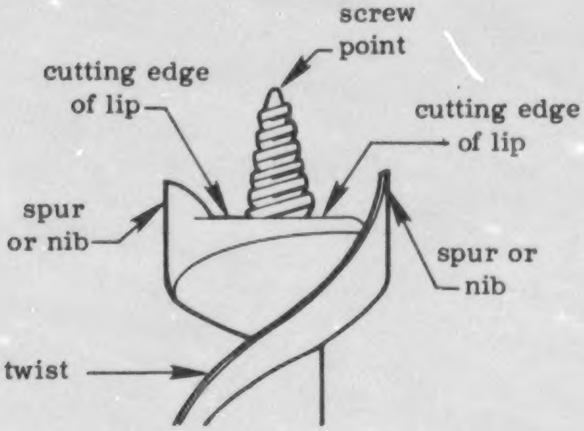
SKILL SHEET - RECONDITIONING AN AUGER BIT

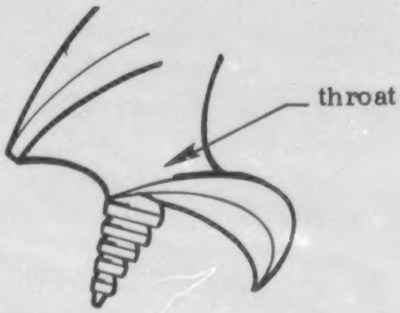
Materials Needed:

Dull auger bit
Tool oil, rag, emery dust, and rope cord
Small ball peen hammer
Auger bit file

Parts of An Auger Bit:

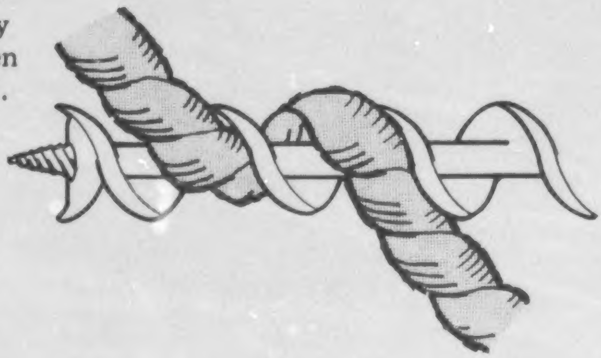

head
twist
shank
solid center
tang


screw point
cutting edge of lip
cutting edge of lip
spur or nib
spur or nib
twist

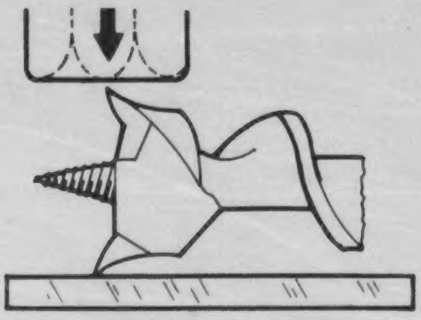


Procedure and Illustration:

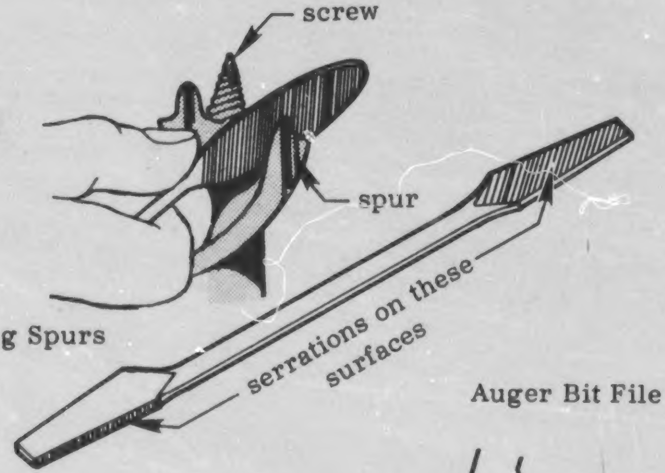
A. If the bit is rusty, polish it with a heavy cord soaked in oil and powdered with emery dust. Work the cord between the twist on the solid center. Put oil and emery dust on a rag to clean the twist edge.



B. Straighten bent auger bit spurs by placing the bit on a piece of metal and tapping lightly with a hammer. Some straightening can be done on other parts of the bit also by tapping with a hammer.



C. Rest the bit on a board with the screw pointing up and file the inside of the spurs with the flat side of the file. Make the filing action only on the forward stroke. Continue to file until the leading edge of the spur has a knife-like edge.

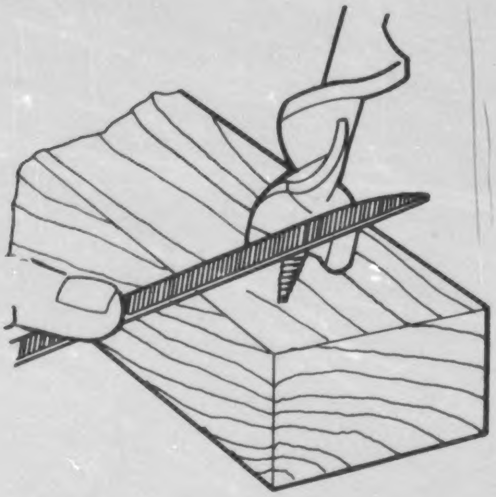


Filing Spurs

Auger Bit File

D. Using the auger bit file, sharpen the cutting lips while resting the feed screw down on a board. File only the upper side or part toward the shank. The lips should be filed at a 25° angle.

E. Reposition the bit and file the opposite cutting lip. Both edges should be filed to the same level to produce chips of equal thickness.



NOTE: Be sure the bit is tilted so that the cutting lip can be sharpened correctly.

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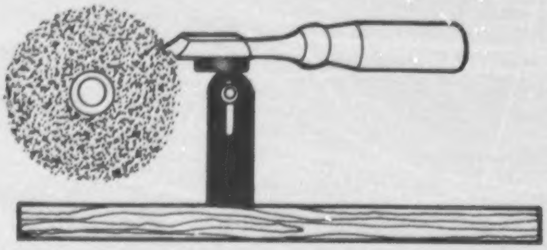
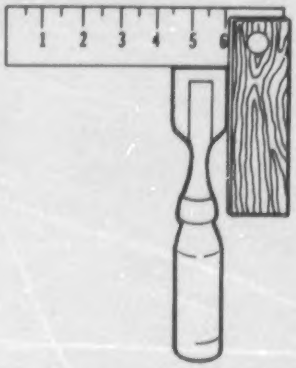
AGRICULTURAL MECHANICS M-3e DATE ________________

SKILL SHEET - SHARPENING PLANE IRONS AND WOOD CHISELS



Materials Needed:

- Dull plane iron and wood chisel
- Grinder with adjustable tool rest
- Try square and angle template or gauge
- Oilstone, oil, and container of water
- Safety glasses

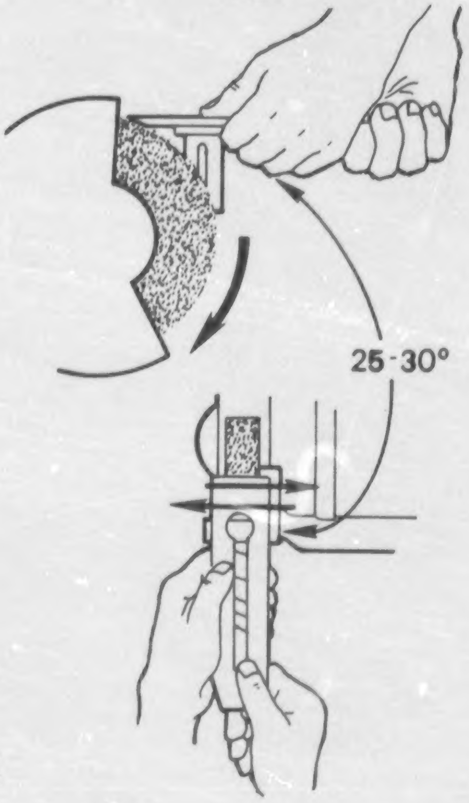


Procedure and Illustration:

A. Place the chisel or iron on the tool rest with the bevel pointing up (perpendicular to wheel).

B. Hold the tool on the rest, lightly touching the grinder wheel, and move the chisel or iron from left to right until the nicks are removed and the edge is square.

C. Check the edge for squareness with the try square.



D. Grind the tool at a 25° to 30° angle with the angle bevel being 3/16" long.

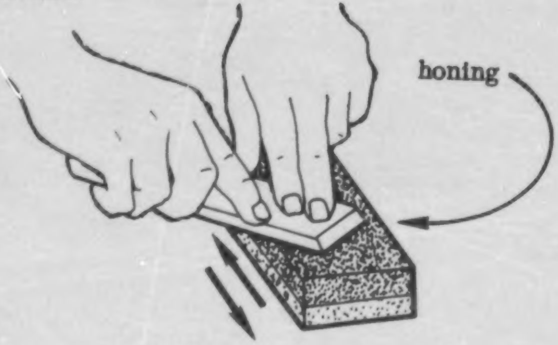
E. Keep the tool perpendicular to the wheel face, and move the chisel or iron from side to side until a wire edge appears on the flat side.

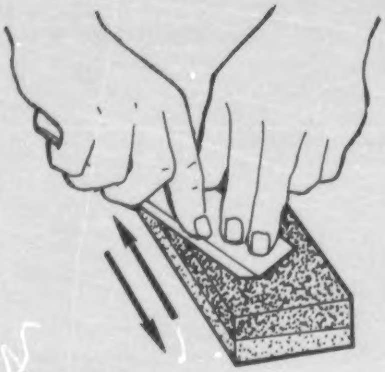
F. Dip the tool in water frequently to keep it cool.

G. Place a few drops of oil on the oilstone.

H. Place the flat side of the blade against the stone and move the blade back and forth until the wire edge is removed.

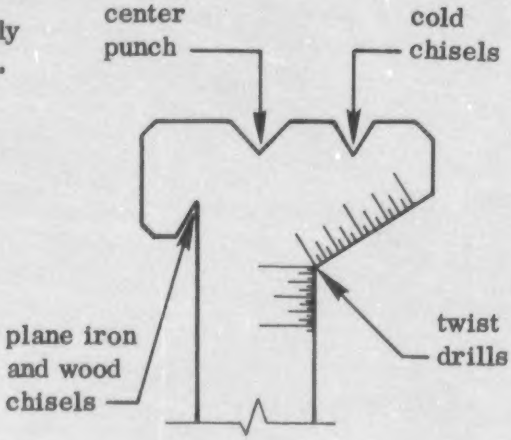
I. Turn the tool over so that the bevel side is down, and apply more pressure on the forward stroke.





J. Slightly round the corners of the cutting edge on the plane iron. This step is not necessary when honing a chisel blade.

K. Check the bevel angle frequently with a template or angle gauge.


center punch
cold chisels
plane iron and wood chisels
twist drills

Template

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SCHOOL ______________

AGRICULTURAL MECHANICS N-1a

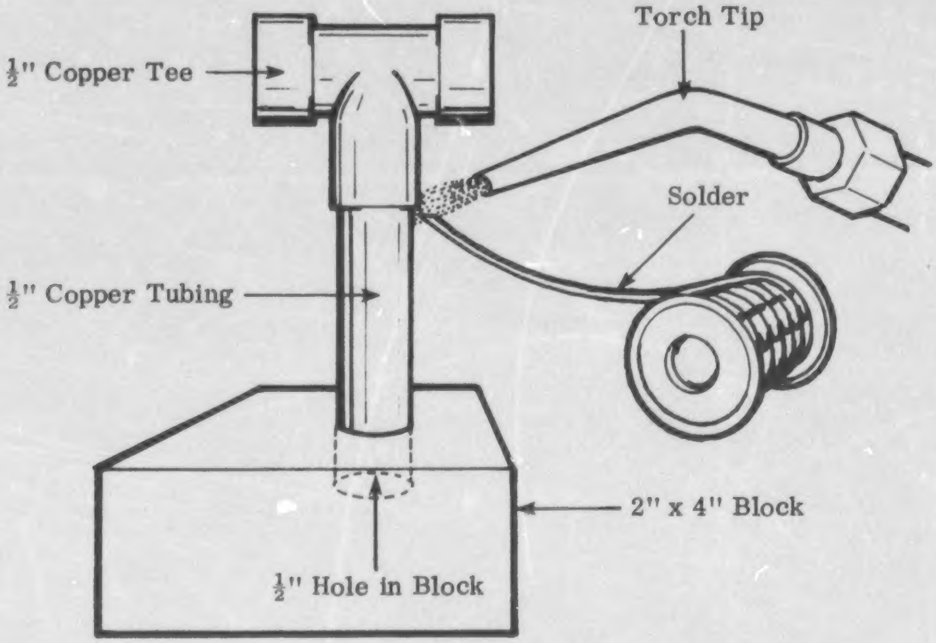
DATE ______________

SKILL SHEET - SOLDERING COPPER TUBING

Materials Needed:

- Oxacetylene rig with welding torch
- Solder and flux
- Safety goggles
- Abrasive cloth
- Copper tubing (1/2")
- Copper fitting (1/2" tee)
- 2" x 4" block with 1/2" hole

Illustration:


½" Copper Tee
Torch Tip
Solder
½" Copper Tubing
2" x 4" Block
½" Hole in Block

Procedure:

A. Remove burrs and rough edges from the inside and outside of the tubing.

B. Clean the end of the tubing and the inside of the fitting (until bright) by rubbing with an abrasive cloth.

C. Apply a thin coat of flux to the inside of the fitting and the cleaned end of the tubing.

D. Push the tubing against the shoulder inside the fitting and turn several times to distribute the flux.

E. Place the other end of the tubing into the hole in the 2"x4" block to secure the work while soldering.

F. Light the torch and adjust to a slightly carburizing flame.

G. Apply heat to the fitting until the flux boils and the copper is hot enough to melt solder.

H. Apply the solder to the opening around the fitting and continue until the joint is filled.

NOTE: Because of capillary action, solder will flow throughout the joint if heat has been properly applied.

I. Remove excess solder with a cloth and allow the joint to cool.

J. Test the joint for water tightness.

K. Additional tubing can be placed in the tee fitting if desired.

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STUDENT ______________________
AGRICULTURAL MECHANICS Q - 1a

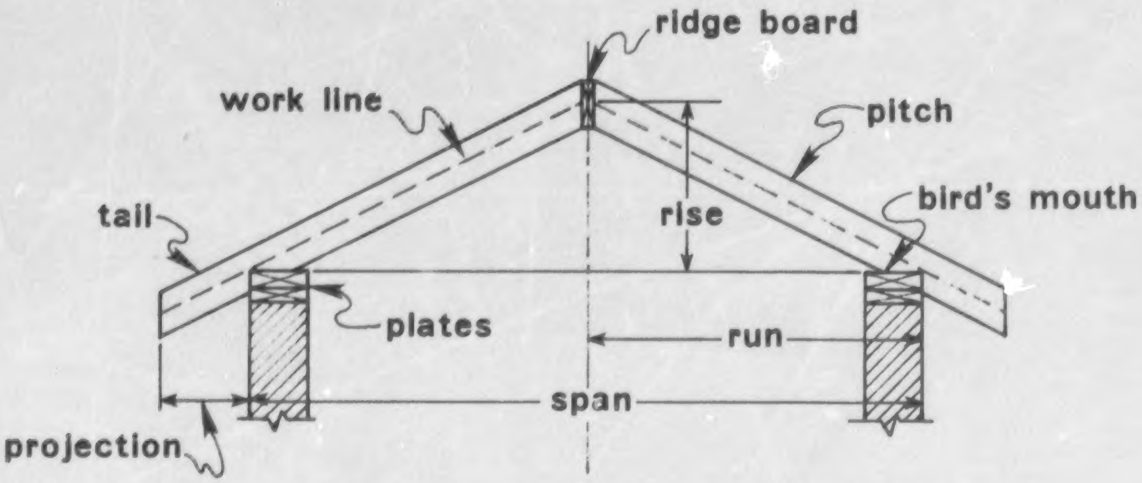
SCHOOL ______________________
DATE ______________________

SKILL SHEET - MARKING AND CUTTING COMMON RAFTERS

Materials Needed:

- Carpenter's framing square
- Pencil
- 2 x 4 lumber for rafter material
- Actual building frame (cattle feeder, portable building, etc.)
- Crosscut handsaw
- Portable electric circular saw

Directions: Read the following explanation, study the carpenter's square, then mark and cut a common rafter using the two methods illustrated.



ROOF FRAMING TERMS

Pitch - refers to the slope of a roof. To determine the pitch, the rise is divided by twice the run. For example, if a building has a run of 14 feet and a rise of 7 feet the pitch is determined as follows:

$$\text{Pitch} = \frac{\text{Rise}}{2 \times \text{Run}}$$

$$\text{Pitch} = \frac{7}{2 \times 14}$$

$$\text{Pitch} = 1/4$$

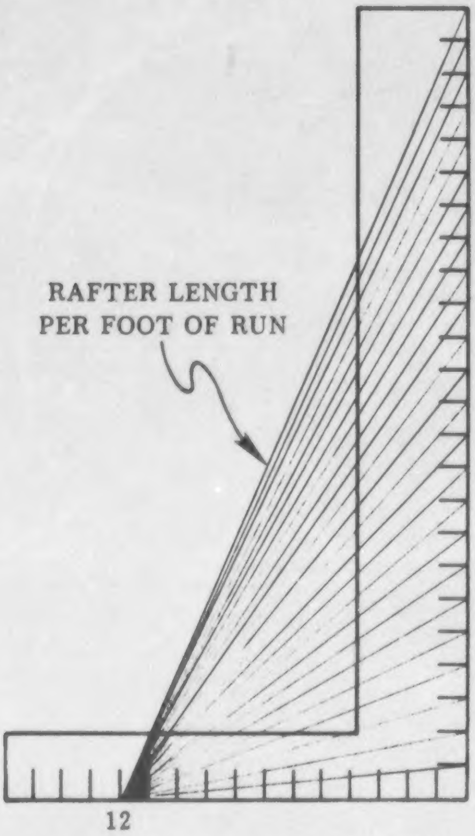
The pitch may also be expressed in inches of rise per foot of run. To determine the rise per foot of run, multiply the fractional pitch by 24". For example, 1/4 x 24" = 6" rise per foot of run.

Span - refers to the distance from the outer edge of one plate to the outer edge of the plate on the opposite side of the structure.

Run - refers to 1/2 the span on equal pitched roofs.

Rise - refers to the vertical distance from the top of the plate to the highest point on the rafter work line.

Bird's Mouth - refers to notch in the rafter that fits over the plate.



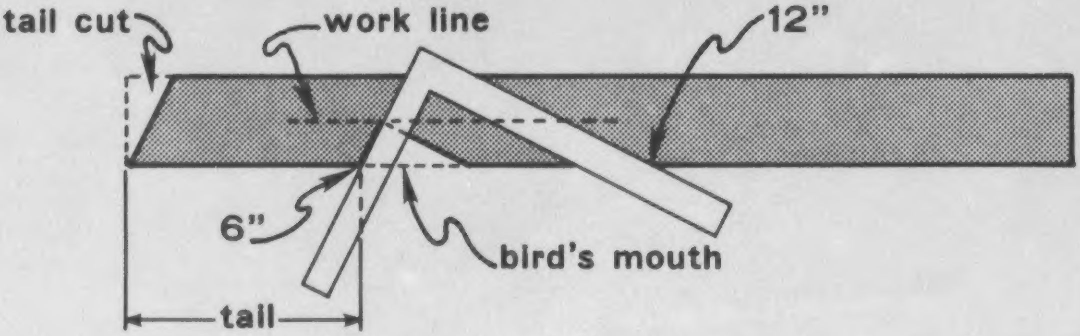
RISE (inches)	ROOF PITCH IN FRACTIONS	LENGTH PER FT. OF RUN (inches)
24	1	26.83
23	23/24	25.94
22	11/12	25.06
21	21/12	24.19
20	5/6	23.32
19	19/24	22.47
18	3/4	21.63
17	17/24	20.81
16	2/3	20.00
15	15/24	19.21
14	7/12	18.44
13	13/24	17.69
12	1/2	16.97
11	11/24	16.28
10	5/12	15.62
9	3/8	15.00
8	1/3	14.42
7	7/24	13.89
6	1/4	13.42
5	5/24	13.00
4	1/6	12.65
3	1/8	12.37
2	1/12	12.16
1	1/24	-
0	0	-

INFORMATION FROM RAFTER TABLE ON CARPENTER'S FRAMING SQUARE

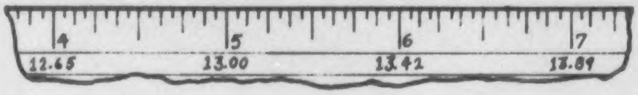
METHODS AND PROCEDURE FOR LAYING OUT AND CUTTING A COMMON RAFTER

Method #1. Using the Rafter Table on the Carpenter's Square
  a. Determine the pitch to be used. (example, 1/4 pitch)
  b. Set the square at 6 and 12 to mark the tail cut of the rafter.
  c. Measure and mark the length desired for the tail of the rafter.
  d. Mark the work line.

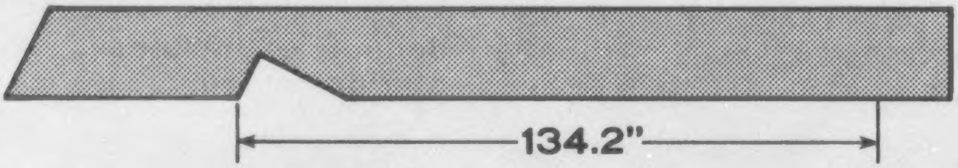
e. Mark the bird's mouth at the point where the rafter is set on the plate. Hold the square at 6 and 12 and mark against the heel of the square. Slide the square back until the edge of the square intersects with the work line and the line just drawn.


tail cut
work line
12"
6"
bird's mouth
tail

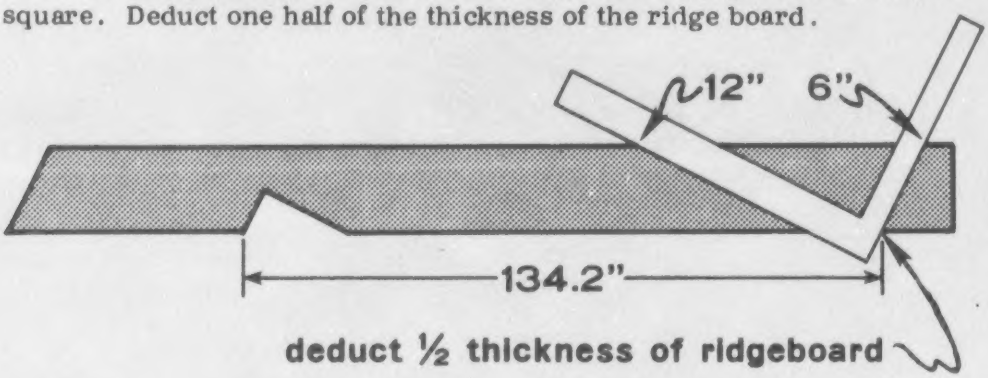
f. Multiply the feet of run times the length per foot of run indicated on the square rafter table. The 1/4 pitch example indicates that the feet of run should be multiplied by 13.42 inches.


4
5
6
7
12.65
13.00
13.42
13.89

g. If the structure has 10 feet of run, then: 10 x 13.42 = 134.2 inches (length of the rafter).



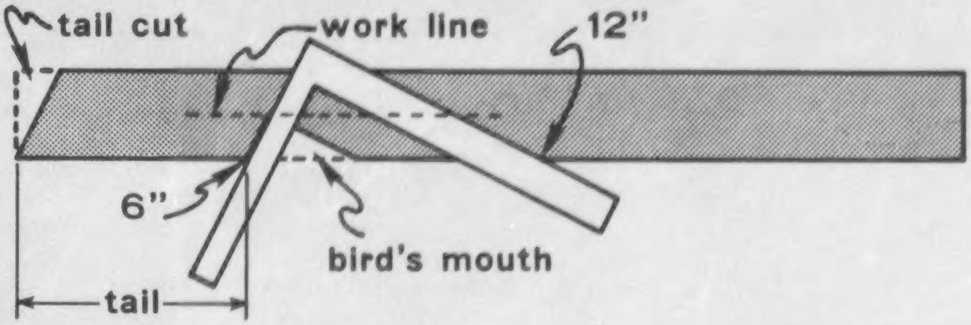
h. Mark the end plumb mark at the 134.2 inch mark using 6 and 12 on the square. Deduct one half of the thickness of the ridge board.


12"
6"
134.2"
deduct ½ thickness of ridgeboard

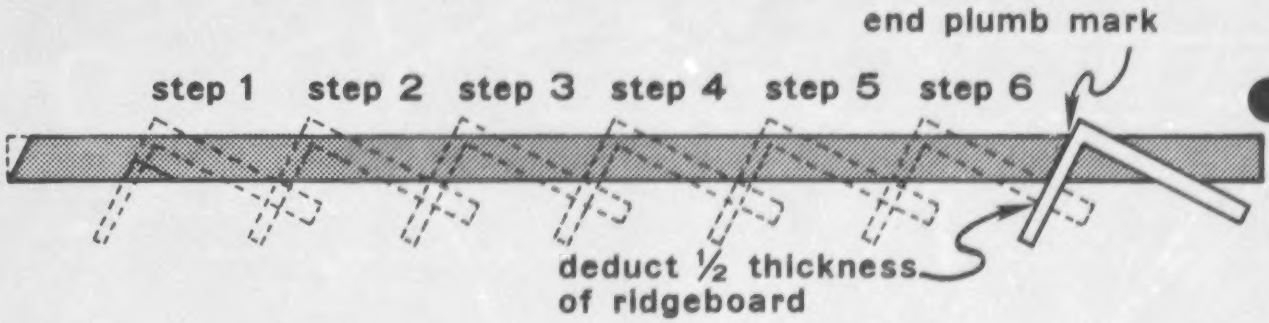
i. Cut the rafter with the portable electric saw and complete the bird's mouth cut with the crosscut handsaw.

Method #2. Using the Stepping Method for Laying Out and Cutting a Common Rafter

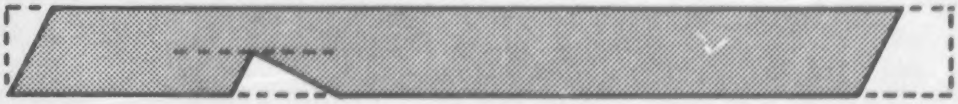
a. Determine the pitch to be used. (example, 1/4 pitch)
b. Set the square at 6 and 12 to mark the tail cut of the rafter.
c. Measure and mark the length desired for the tail of the rafter.
d. Mark the work line.
e. Mark the back of the bird's mouth using 6 and 12 on the square. Slide the square back until the edge of the square intersects with the work line and the line just drawn.


tail cut
work line
12"
6"
bird's mouth
tail

f. Take one step per foot of run with the square. If the run of the structure is 6 feet, take 6 steps with the square set at 6 and 12. Begin the first step at the back of the bird's mouth. Make the end plumb mark at the last step, then deduct the thickness of half of the ridge board.


end plumb mark
step 1
step 2
step 3
step 4
step 5
step 6
deduct ½ thickness of ridgeboard

g. Cut the rafter with the portable electric saw and complete the bird's mouth cut with the crosscut hand saw.



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AGRICULTURAL MECHANICS R-1a DATE ____________________

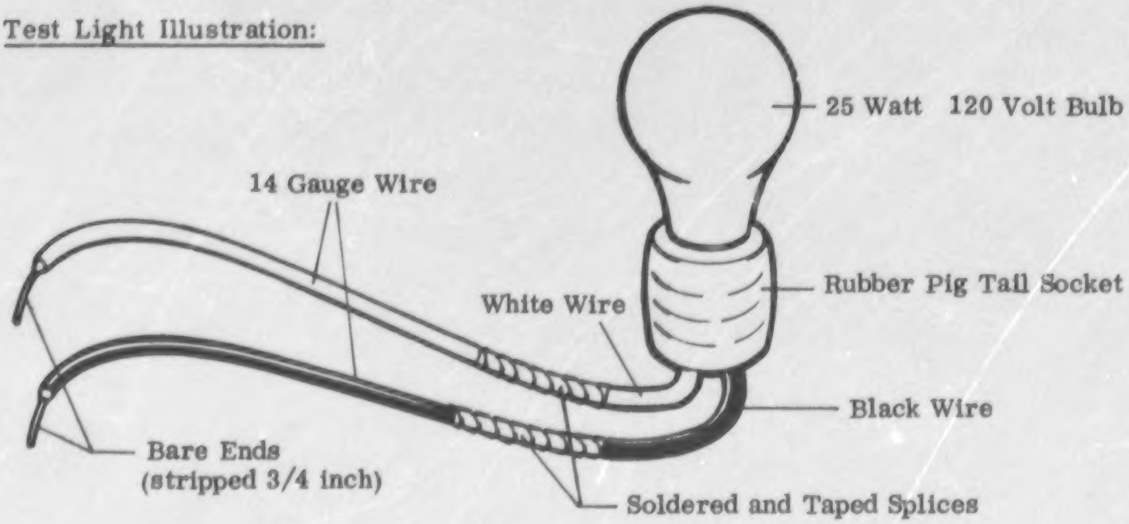
SKILL SHEET - MAKING AND USING A TEST LIGHT

Materials Needed:

- 1-25 watt 120 volt bulb
- 1 Rubber pig tail socket
- 2-2 foot pieces # 14 TW wire
- Black plastic tape
- Knife or wire stripper
- Wire cutter
- Rosin core solder
- Soldering iron
- Extension cord
- Circuit for testing

Directions: Study the following illustration and assemble a test light. As directed by the instructor, test circuits for shorts and polarity.

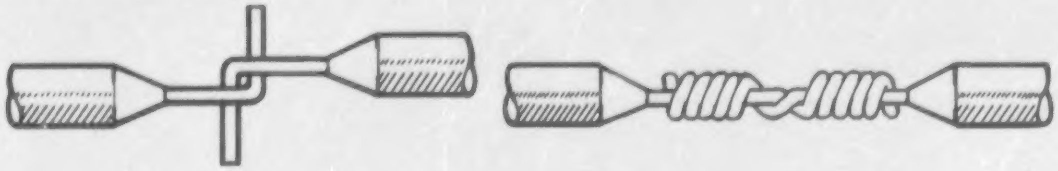
Test Light Illustration:


25 Watt 120 Volt Bulb
14 Gauge Wire
Rubber Pig Tail Socket
White Wire
Black Wire
Bare Ends
(stripped 3/4 inch)
Soldered and Taped Splices

Procedure:

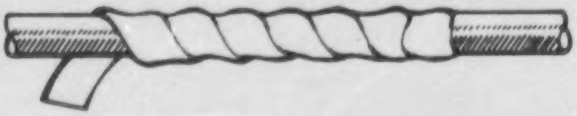
A. Using the wire stripper, remove approximately three inches of insulation from each pig tail wire and from one end of each of the wires to be spliced on.

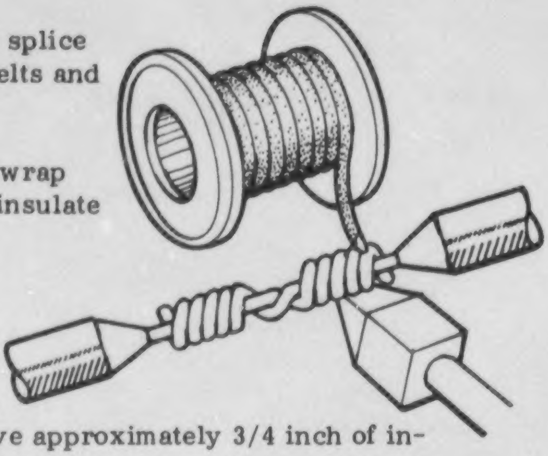
B. Use the western union splice to attach the two wires to the pig tails.



C. Properly apply rosin core solder to the splice by heating the wires until the solder melts and flows into every crevice.

D. Allow the splice to cool, then properly wrap the splice with plastic tape to seal and insulate the connection.





E. Using the knife or wire stripper, remove approximately 3/4 inch of insulation from the ends of the two wires.

F. Screw in the light bulb and with the instructor's permission complete the following tests:

CAUTION: When using the test light, make certain that the leads are held in a manner that will prevent the fingers or body from coming in contact with the stripped ends or the metal being used for the ground.

1. CIRCUIT TEST

(a) Attach one test light lead to a ground (metal water or gas line) and the other lead to the metal case of an appliance or power tool, then reverse the plug on the power lead. If the appliance or tool has a short the light will burn in one of the positions.

(b) Touch one test light lead to a ground (metal water or gas line) and the other to a terminal on a single pole switch.

(c) Touch one test light lead to a ground and the other to a traveler wire terminal on a three-way switch.

(d) Insert one test light lead into the neutral side (silver terminal, large slot) and the other lead into the energized side (brass terminal, small slot) of a duplex outlet.

(e) Insert one test light lead into the safety ground slot of a duplex outlet and the other lead into the energized side (brass terminal, small slot).

(f) Attach one test light lead to a ground (water or gas line) and insert the other lead into the energized side (brass terminal, small slot) of a duplex outlet.

2. POLARITY TEST

Many extension cords do not have polarized plugs; therefore, when one is to be used as a power lead for a demonstration board, it must be polarized. To do this, plug the extension cord into a duplex outlet, attach one lead of the test light to a known ground (water or gas line), and insert the other lead into the extension cord plug to locate the energized (hot) side of the plug. Polarization insures that the neutral is a true neutral.

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STUDENT ____________________ SCHOOL ________________

AGRICULTURAL MECHANICS R-1b DATE __________________

SKILL SHEET - WIRING A 120 VOLT LIGHT CIRCUIT CONTROLLED BY A SINGLE - POLE SWITCH

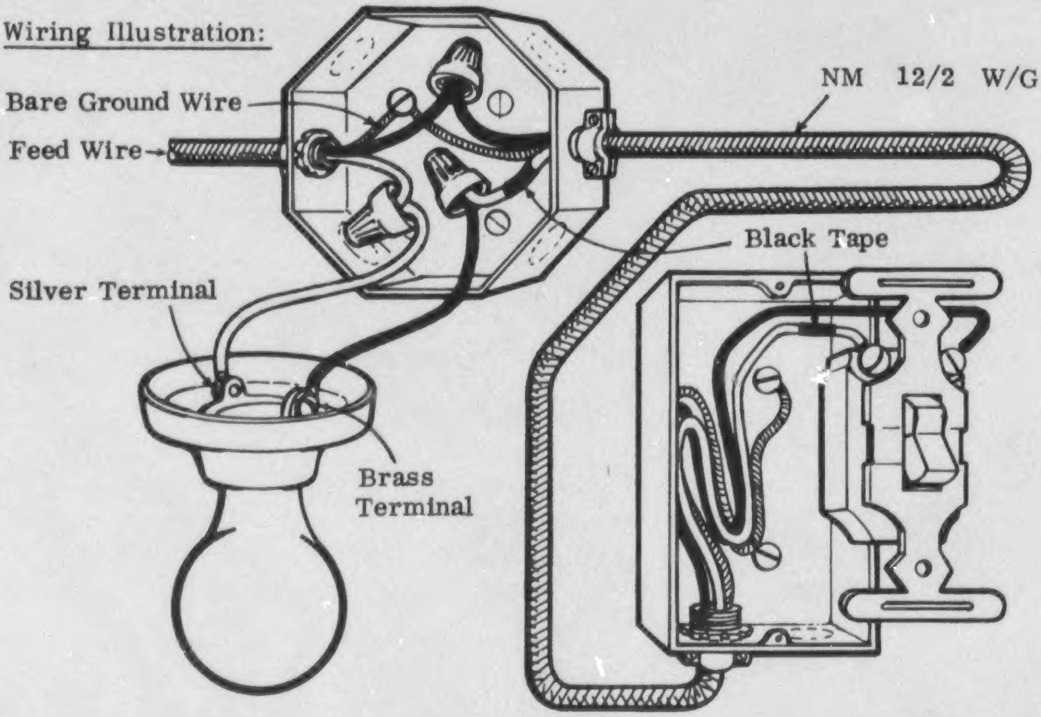
Materials Needed:

Porcelain lamp receptacle
Junction box
Single-pole toggle switch and cover
Switch outlet box
4 feet No. 12/2 Romex with ground
Plywood demonstration board (2'x3'x 3/8")

Standard screwdriver
Lineman's pliers
Needle-nose pliers
Knife and wire stripper
Solderless connectors
Romex clamps

Directions: Study the following illustration and complete the wiring exercise as directed by the instructor.

Wiring Illustration:



Procedure:

A. Attach the junction box and switch receptacle to the demonstration board at the desired locations.

B. Remove the knock out plugs in both boxes and run adequate wire to each box and allow approximately 6 inches to extend from each box to make connections.

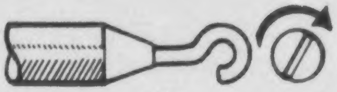
C. Tighten the Romex clamps on each box.

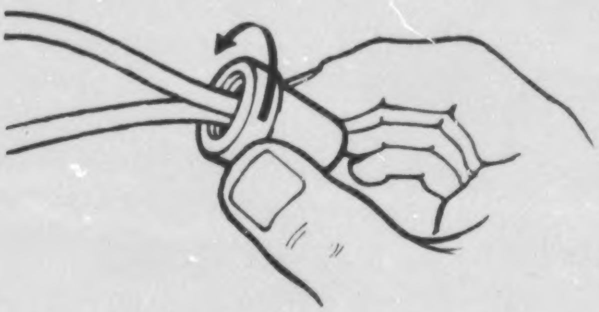
D. Attach wires to the lamp receptacles, black wire to the brass terminal and white wire to the silver terminal.

E. Remove 4 inches of outside insulation from the wire and strip approximately 1 1/2 inches of insulation from each wire inside the junction box. Strip about 3/4 inch of insulation from each wire inside the switch receptacle. Care should be taken not to cut or score the conductor.

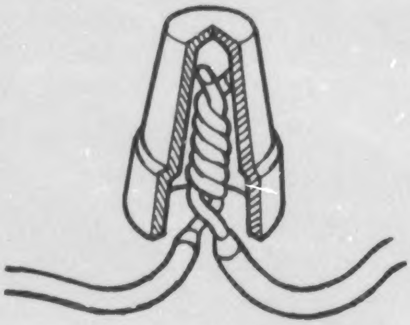
F. Connect the single-pole switch to the wires extending from the switch receptacle. Wires should be placed around the terminals according to the way the screw turns to tighten.

G. All splices should be made inside the junction box with the insulated solderless connectors.





Tighten Clockwise



Cut-Away View of Pigtail Splice

H. Designate the white wire returning from the switch and attaching to the black wire from the lamp receptacle as hot by wrapping with black tape.

I. Connect the bare ground wire to a screw or use a clip inside the junction box and switch receptacle to provide a safety ground.

J. Trace the circuit to see that current will flow through the switch then to the light.

K. Attach the light receptacle and switch to the boxes and place the cover plate over the switch.

L. Upon approval by the instructor, connect the wire extending from the junction box to the power source and check the operation of the circuit.
CAUTION: Polarize prior to connecting the feed wire to the power source. (This insures the power will go through the switch first on the black wire and that the white wire is neutral).

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AGRICULTURAL MECHANICS R-1c

DATE ______________________

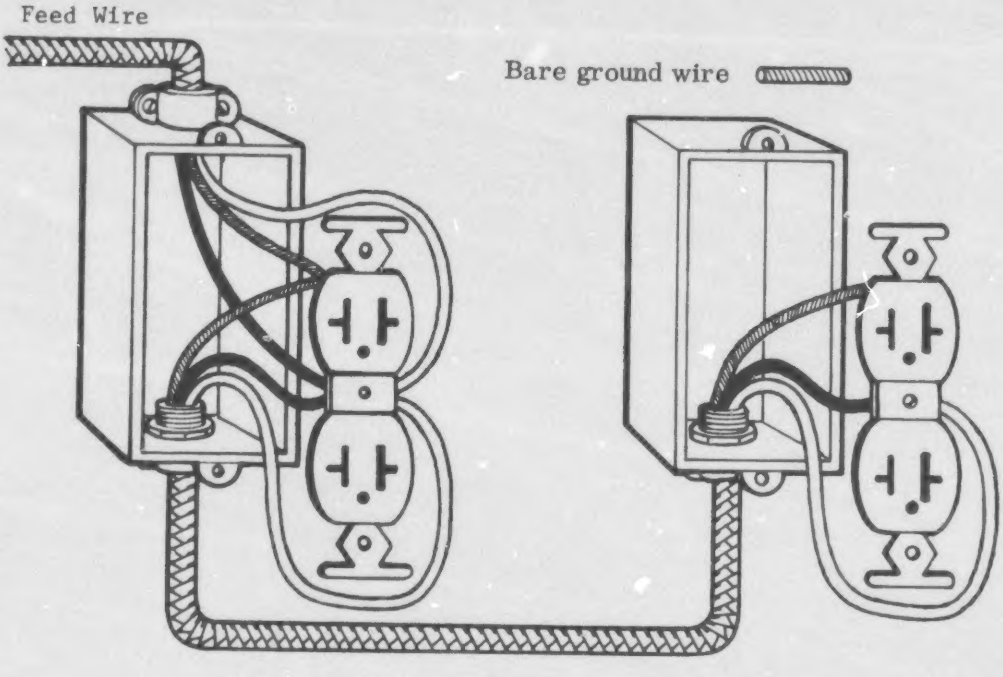
SKILL SHEET - WIRING TWO DUPLEX RECEPTACLES IN A 120 VOLT CIRCUIT

Materials Needed:

- Two duplex receptacles and cover plates
- Two flush wall boxes
- 4 feet No 12/2 Romex with ground
- Plywood demonstration board (2'x3'x 3/8")
- Standard screwdriver
- Lineman's pliers
- Needle-nose pliers
- Knife and wire stripper
- Romex clamps

Directions: Study the following illustration and complete the wiring exercise as directed by the instructor.

Wiring Illustration:



Procedure:

A. Attach the receptacle boxes to the demonstration board at the desired locations.
B. Remove two knock-out plugs in the first box and one plug in the second.
C. Cut the wire in two pieces and run the feed wire into the first box. Connect the boxes with the second wire.
D. Pull the wires to extend out of the boxes approximately 6 inches.
E. Tighten the screws on the Romex clamps to secure the wire.
F. Remove 4 inches of outside insulation from the wire and strip about 3/4 inch (check the strip gage) of insulation from each wire.
G. Attach the black wires (hot) to the brass side of the receptacles.
H. Attach the white wires (neutral) to the silver side of the receptacles.
I. Attach the bare wire (ground) to the designated terminal on each receptacle.

NOTE: The wire should be placed around the terminals according to the direction the screw tightens. Some receptacles require the wires to be inserted into contact clamps after being properly stripped.

J. Attach the receptacles to the boxes then place the cover plates over the receptacles.
K. Upon approval by the instructor, connect the wire extending from the first box to the power source and check the operation of the circuit.

CAUTION: To insure that power is carried by the black wire, polarize before connecting the feed wire to the power source.

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AGRICULTURAL MECHANICS R-1d

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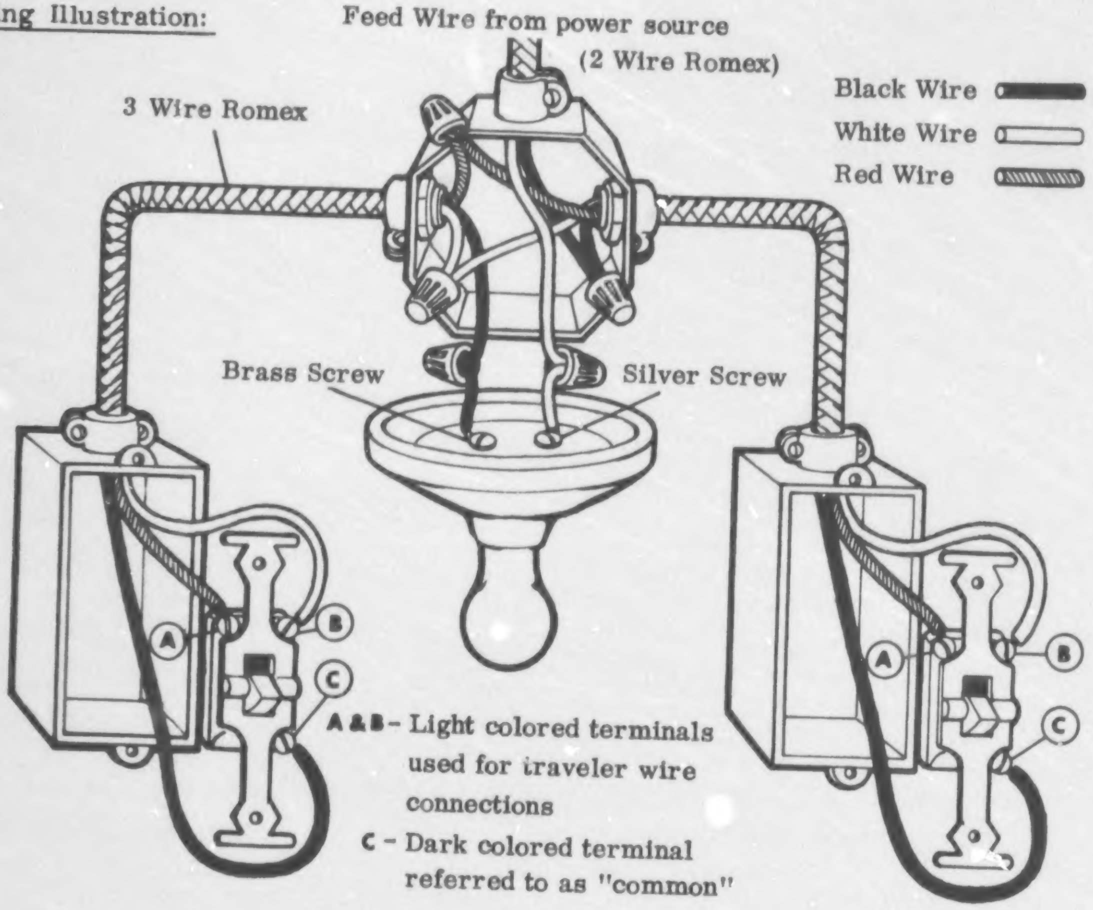
SKILL SHEET - WIRING A 120 VOLT LIGHT CIRCUIT CONTROLLED BY TWO THREE-WAY SWITCHES

Materials Needed:

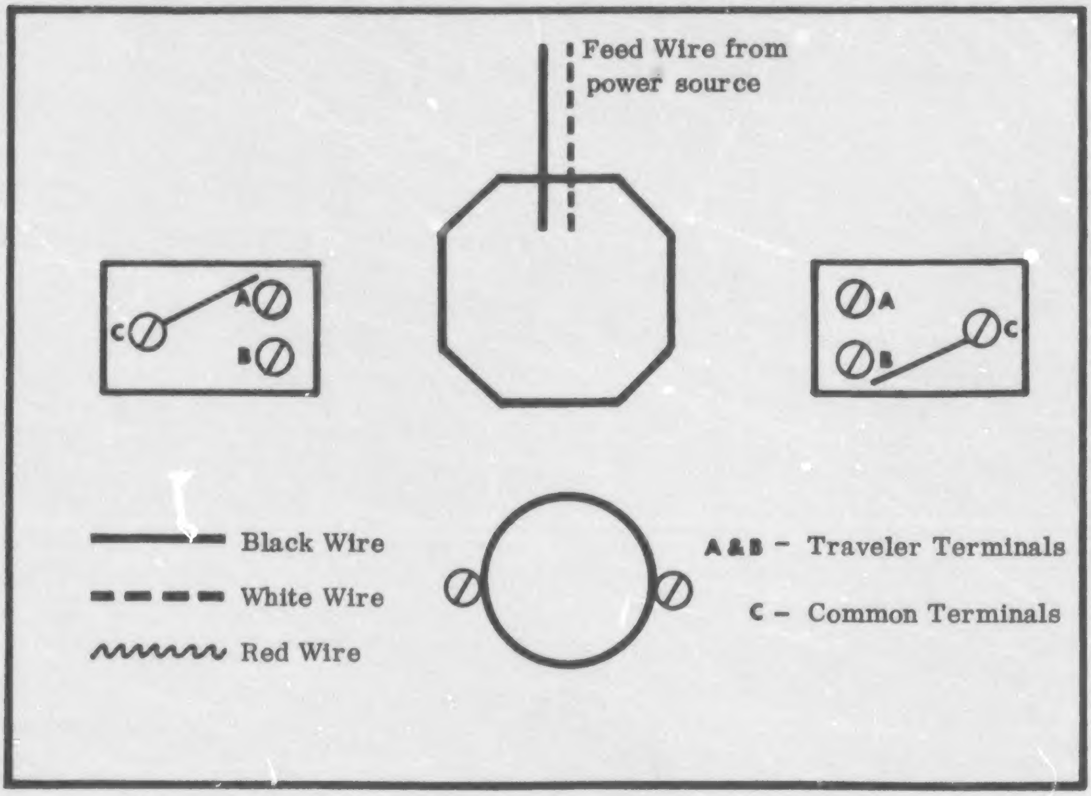
- Porcelain lamp receptacle
- Junction box
- Two three-way switches and cover plates
- Two switch outlet boxes
- Two pieces of 12/3 Romex, two feet long
- One piece of 12/2 Romex, two feet long
- Plywood demonstration board (2'x3'x 3/8")
- Standard screwdriver
- Lineman's pliers
- Needle-nose pliers
- Knife or wire stripper
- Black plastic tape
- Solderless connectors
- Romex clamps

Directions: Study the following illustration and complete the schematic diagram that follows. As directed by the instructor, assemble and wire the demonstration board.

Wiring Illustration:


Feed Wire from power source
(2 Wire Romex)
3 Wire Romex
Black Wire
White Wire
Red Wire
Brass Screw
Silver Screw
A
B
C
A
B
C
A & B - Light colored terminals used for traveler wire connections
C - Dark colored terminal referred to as "common"

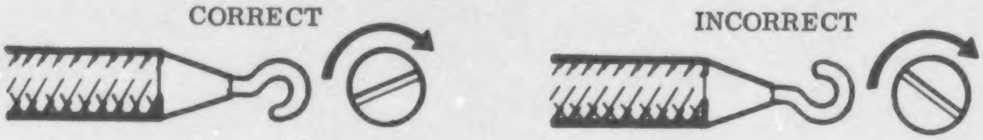
Schematic Diagram:



Procedure:

A. Attach the junction box and switch receptacles to the demonstration board at the desired locations.
B. Remove approximately five inches of the outside insulation from each end of all three pieces of Romex cable.
C. Remove three knock out plugs from the junction box.
D. Remove one knock out plug from each of the switch receptacles.
E. Connect the two switch receptacles to the junction box by inserting the 12/3 Romex cable.
F. Insert the 12/2 Romex cable into the junction box to serve as the feed wire from the power source.
G. Allow approximately five inches of each cable to project from the junction box and switch receptacles.
H. Tighten the screw on each Romex clamp. Be sure to secure the Romex cable without cutting the insulation with the clamp.
I. Remove approximately one inch of insulation from each wire.
J. Connect the black wire in each switch receptacle to the common terminal of each three-way switch.
K. Connect the red wire and white wire in each switch receptacle to the traveler wire terminals on the switch.

L. The wires should be placed around the switch terminals according to way the screw turns to tighten.


CORRECT

INCORRECT

Connections At Screw Terminals

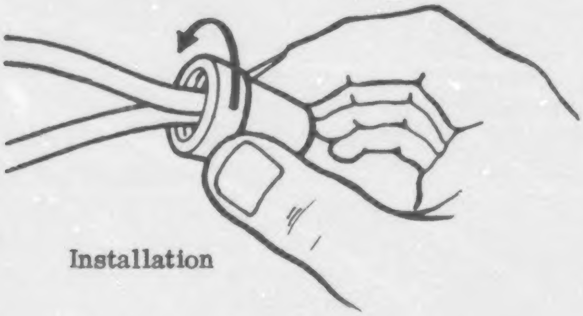
M. Connect the other ends of the traveler wires inside the junction box (red to red and white to white) with solderless connectors.

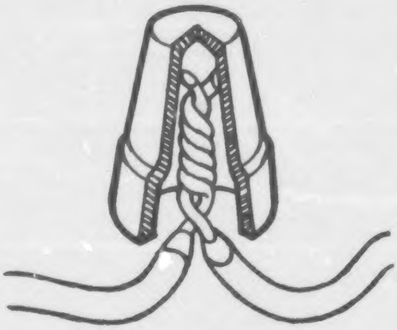
N. The black wire inside the feed wire should be spliced onto the black wire going to one switch.

O. The white wire inside the feed wire should be spliced onto the white wire attached to the silver screw on the porcelain receptacle.

P. The black wire from the other switch should be spliced to the black wire attached to the brass screw on the porcelain receptacle.

Q. All splices inside the junction box should be made with solderless insulated connectors.


Installation


Cut-Away View

R. The white traveler wires inside the junction box and switch receptacles should be marked with black tape to indicate that they are not neutral.

NOTE: If the circuit is to be grounded, the ground wire should run from the neutral bar of the service panel through the feed wire and be attached to the junction box and switch receptacles.

S. Check with the instructor before pushing wires back into the boxes, fastening the porcelain receptacle and switches, and installing the switch cover plates.

CAUTION: Be sure to polarize prior to connecting the feed wire to the power source. (This insures that the black wire is hot and carries current directly to the switch and also insures that the white wire is neutral).

T. Connect the feed wire extending from the junction box to the power source.

U. Turn the switches off and on to check for proper operation.

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AGRICULTURAL MECHANICS R-2a

SCHOOL ____________

DATE ____________

SKILL SHEET - CHECKING RUNNING AND STARTING WINDINGS ON SPLIT-PHASE ELECTRIC MOTORS

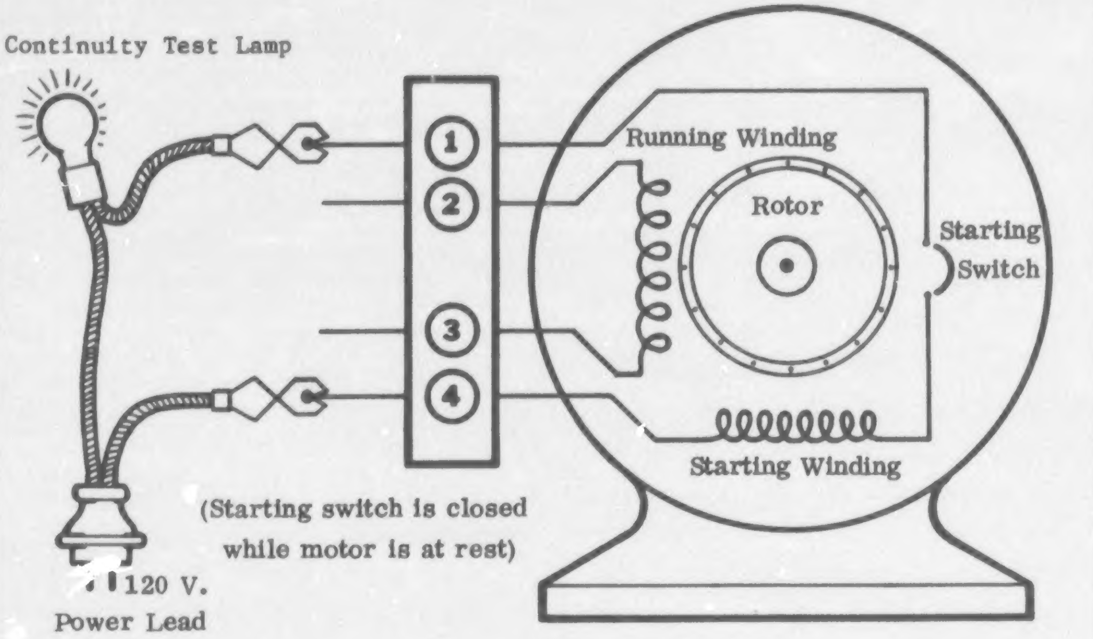
Materials Needed:

Split-phase electric motor (single voltage)
Socket wrench set
Screwdriver
Continuity test lamp
Power lead with male plug and insulated clips

Procedure and Illustration:

A. Remove the motor terminal plate and disconnect the wiring leads from the terminal block.

B. Check for shorts by connecting one lead of the continuity test lamp to one end of a motor winding, energize the continuity tester, and touch the other lead of the tester to the motor frame. If a light occurs, a short is indicated and repair is necessary. NOTE: Check both windings for shorts.


Continuity Test Lamp
1
2
3
4
Running Winding
Rotor
Starting Switch
Starting Winding
(Starting switch is closed while motor is at rest)
120 V.
Power Lead

Testing starting and running windings on a split-phase single-voltage motor. Test starting winding as shown. Test running winding by attaching test leads to #2 and #3.

C. Determine which two leads complete a circuit for each winding (starting and running). A light should occur when the starting winding leads are paired and when running winding leads are paired.
NOTE: If a light is obtained between all four leads, the windings are shorted and should be repaired.

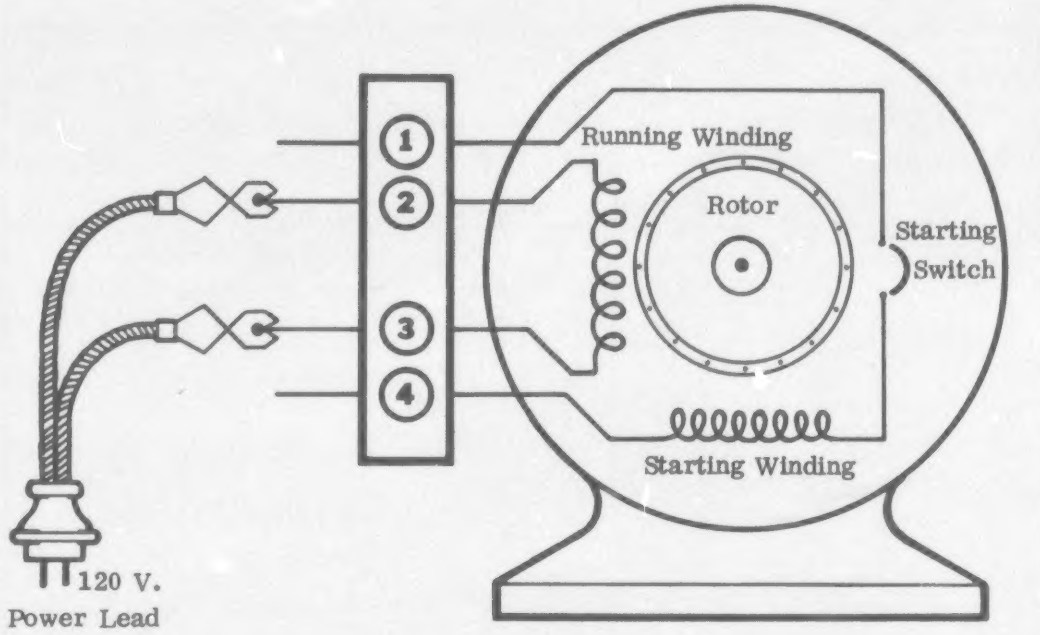
D. Connect the two ends of the running winding to the power leads and insert the male plug into an electrical outlet.

E. When the motor starts to hum, twist the shaft of the motor by hand in a clockwise direction and the motor will operate in that direction.

F. Unplug the power lead and allow the motor to come to a complete stop.

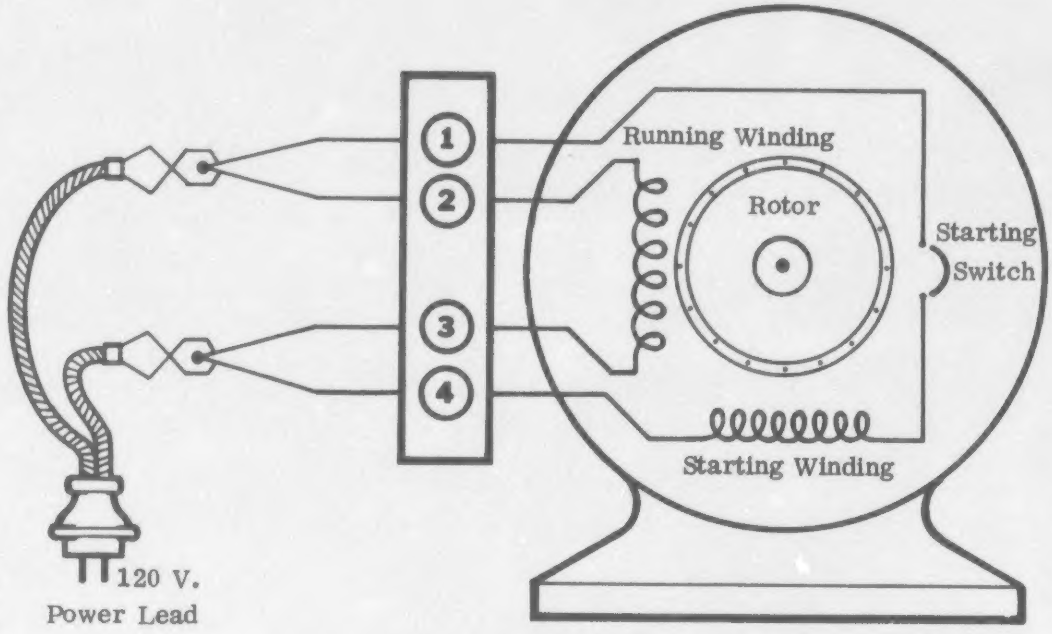
G. Plug the power lead in again, listen for hum, and twist the shaft in a counter-clockwise direction and the motor will operate in that direction.
NOTE: This proves that the motor will operate equally well in either direction, depending upon the direction in which it is started.

H. Unplug the power lead and allow the motor to come to a complete stop.



Connecting running windings to power leads on a split-phase single-voltage motor.

I. Connect the ends of the starting winding to the ends of the running winding and connect to the power leads. (Windings are connected in parallel.)


1
2
3
4
Running Winding
Rotor
Starting Switch
Starting Winding
120 V.
Power Lead

Circuit diagram for a split-phase single-voltage motor operating in one direction.

J. Plug the power lead into an electrical outlet and the motor will start automatically, come up to full speed, and continue to run.

K. Start and stop the motor several times and listen to the "click" in the motor. This is the switch in the starting winding opening and closing. NOTE: When the motor comes up to about 80 percent of its full speed, the starting switch opens and the starting winding is no longer functional. When the motor stops, the switch closes and the starting winding is engaged for the next start.

L. Unplug the power lead.

NOTE: Proceed to SKILL SHEET R-2b.

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STUDENT ________________ SCHOOL ______________

AGRICULTURAL MECHANICS R-2b DATE ______________

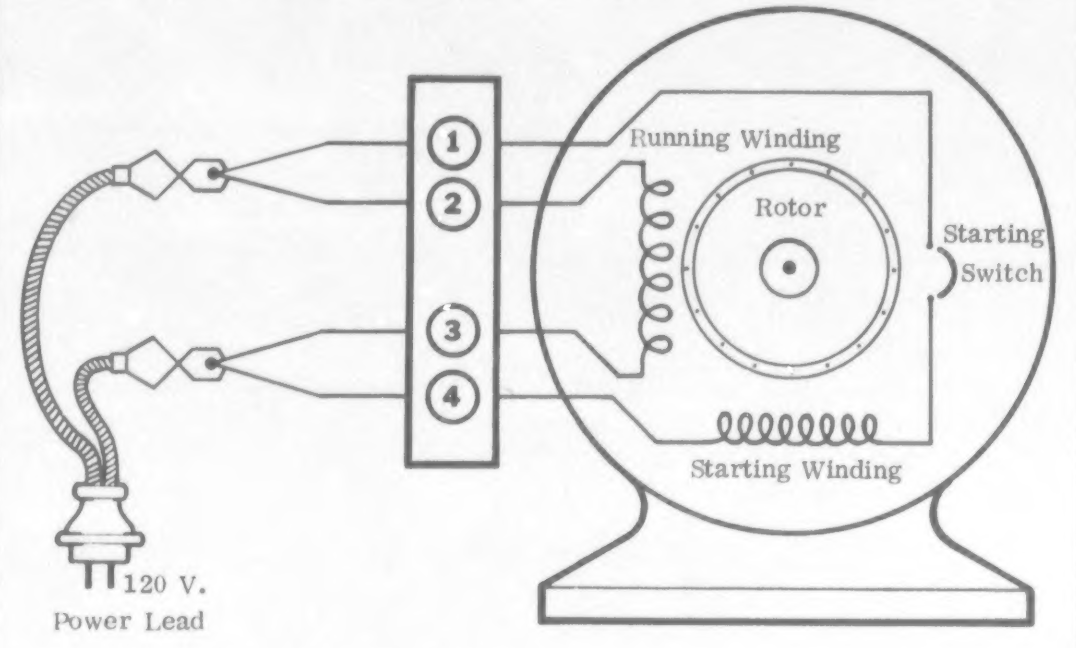
SKILL SHEET - CHANGING DIRECTION OF ROTATION ON SPLIT - PHASE ELECTRIC MOTORS

Materials Needed:

- Split-phase electric motor (single-voltage)
- Socket wrench set
- Screwdriver
- Continuity test lamp
- Power lead with male plug and insulated clips

Procedure and Illustration:

A. Complete SKILL SHEET R-2a, CHECKING RUNNING AND STARTING WINDINGS ON SPLIT-PHASE ELECTRIC MOTORS.



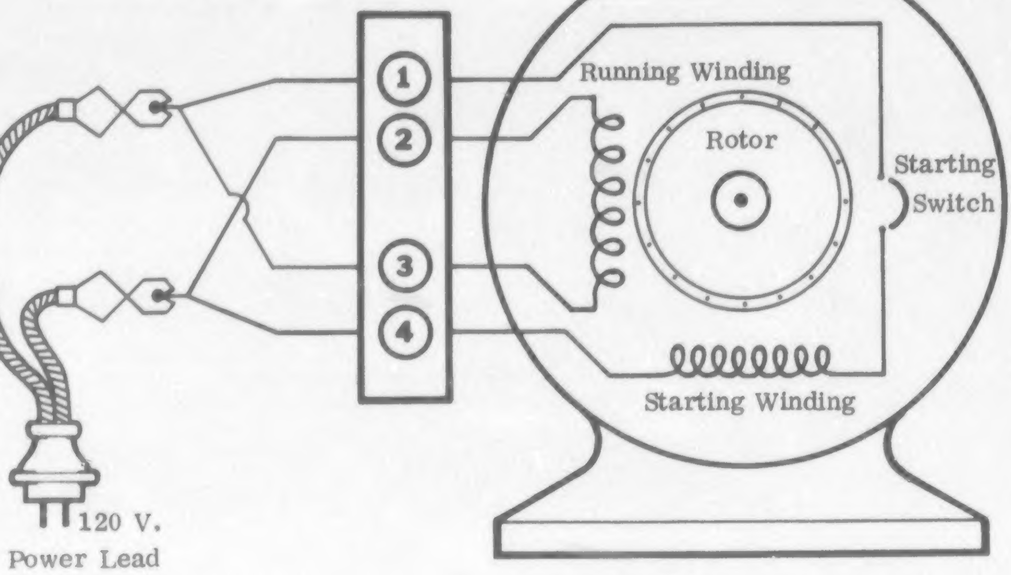
1
2
3
4
Running Winding
Rotor
Starting
Switch
Starting Winding
120 V.
Power Lead

Circuit diagram for a split-phase single-voltage motor operating in one direction.

B. Connect the windings as indicated above, plug the power lead in, and start the motor. Make note of the direction of rotation.

C. Unplug the power lead and allow the motor to completely stop.

D. Switch the two ends of the starting winding with respect to the ends of the running winding and again connect to the power lead.


1
2
3
4
Running Winding
Rotor
Starting Switch
Starting Winding
120 V.
Power Lead

Circuit diagram for a split-phase single-voltage motor operating in opposite direction.

E. Plug in the power lead.

F. The motor should start and run in the opposite direction.

G. Unplug the power lead and allow the motor to completely stop.

NOTE: To reverse a motor equipped with a terminal (block) plate, it may be easier to interchange the running winding leads on the terminals than to reverse the starting winding leads.

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AGRICULTURAL MECHANICS R-2c DATE ______________

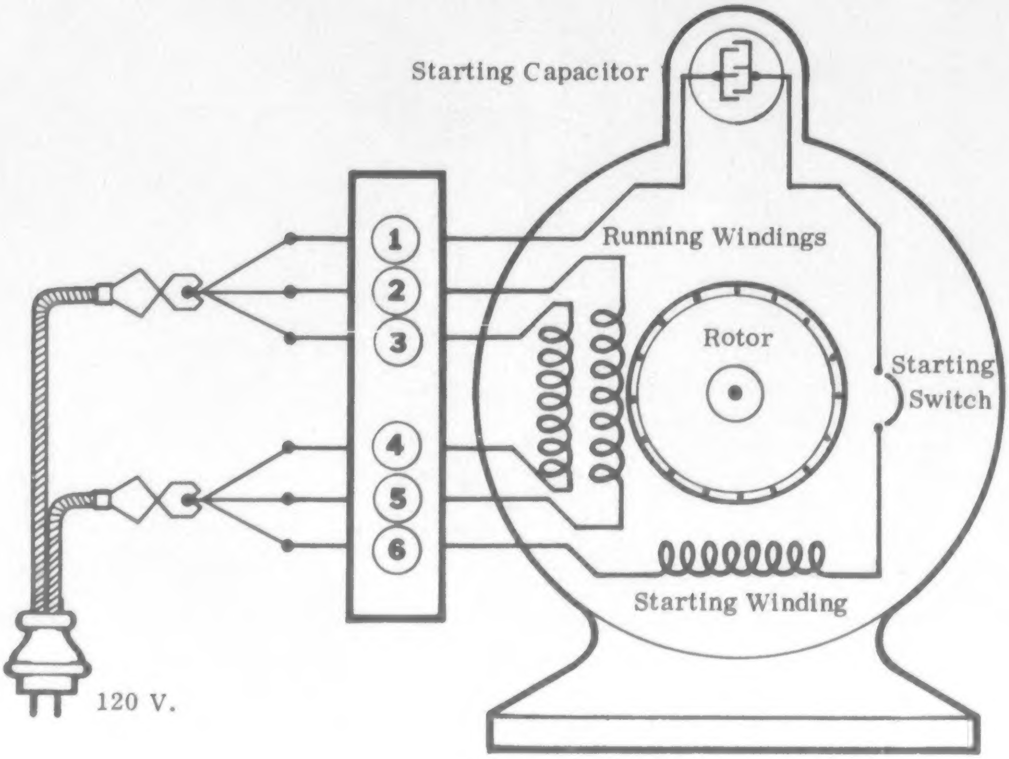
SKILL SHEET - CHANGING DIRECTION OF ROTATION ON DUAL-VOLTAGE CAPACITOR-START ELECTRIC MOTORS

Materials Needed:

Capacitor-start electric motor (dual-voltage)
Socket wrench set
Screwdriver
Continuity test lamp and black electrical tape
Power lead with male plug and insulated clips

Procedure and Illustration:

A. Remove the motor terminal plate.
B. Check for shorts with the continuity tester.
C. Determine and label the three circuits (One starting winding and two running windings).


Starting Capacitor
1
2
3
4
5
6
Running Windings
Rotor
Starting Switch
Starting Winding
120 V.

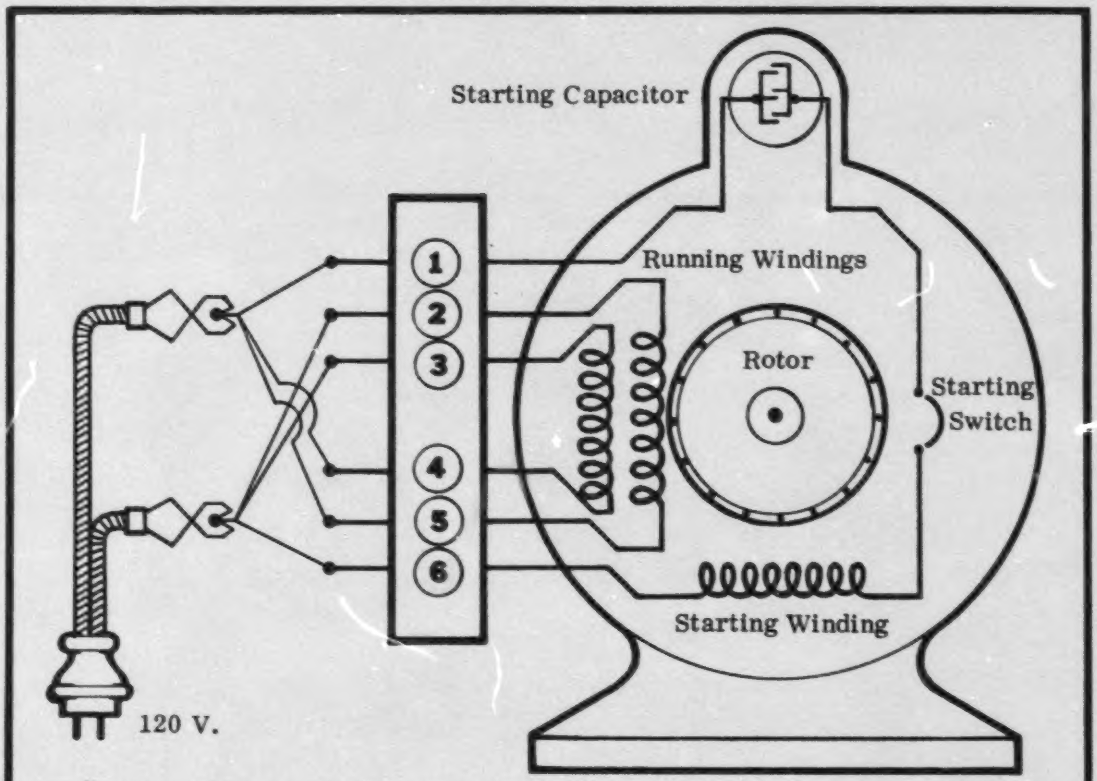
Circuit diagram for a dual-voltage capacitor-start motor wired to operate on 120 V. in one direction.

D. To operate a dual voltage motor on 120 volts, connect one end of each of the windings to one power lead and the other end of each of the windings to the other power lead.

E. Plug the power lead into an electrical outlet. The motor should operate in one direction.
NOTE: If the motor does not run properly, disconnect from the power source and switch the ends of the running windings. Plug in the power lead and the motor will run properly.

F. Unplug the power lead and allow the motor to stop.

G. To reverse direction of rotation, disconnect the ends of the starting winding from the running windings and switch the connections.



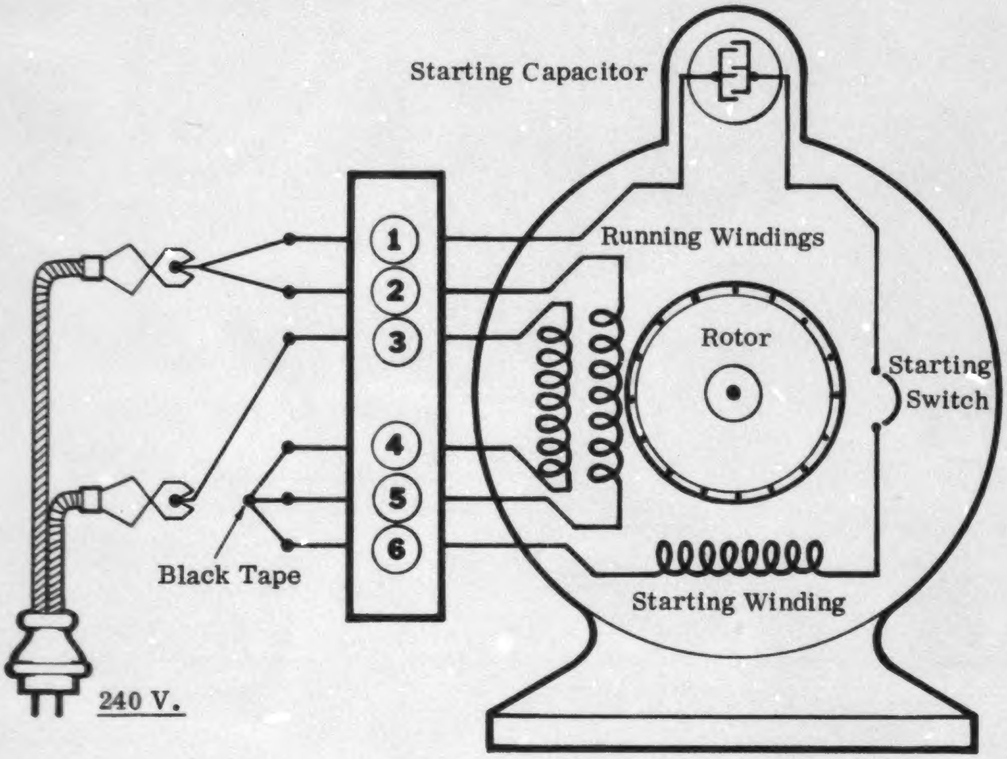
Circuit diagram for a dual-voltage capacitor-start wired to operate on 120 V. in opposite direction.

H. Plug in the power lead and observe the change in direction of rotation.

I. Unplug the power lead and allow the motor to stop.

J. To operate a dual-voltage capacitor-start motor on 240 volts, connect one end of the starting winding and one end of each of the two running windings together and wrap with tape.

K. Connect the remaining end of the starting winding and one of the remaining ends of the running windings to one power lead and the other end of the remaining running winding to the other power lead.


Starting Capacitor
Running Windings
1
2
3
4
5
6
Rotor
Starting Switch
Black Tape
Starting Winding
240 V.

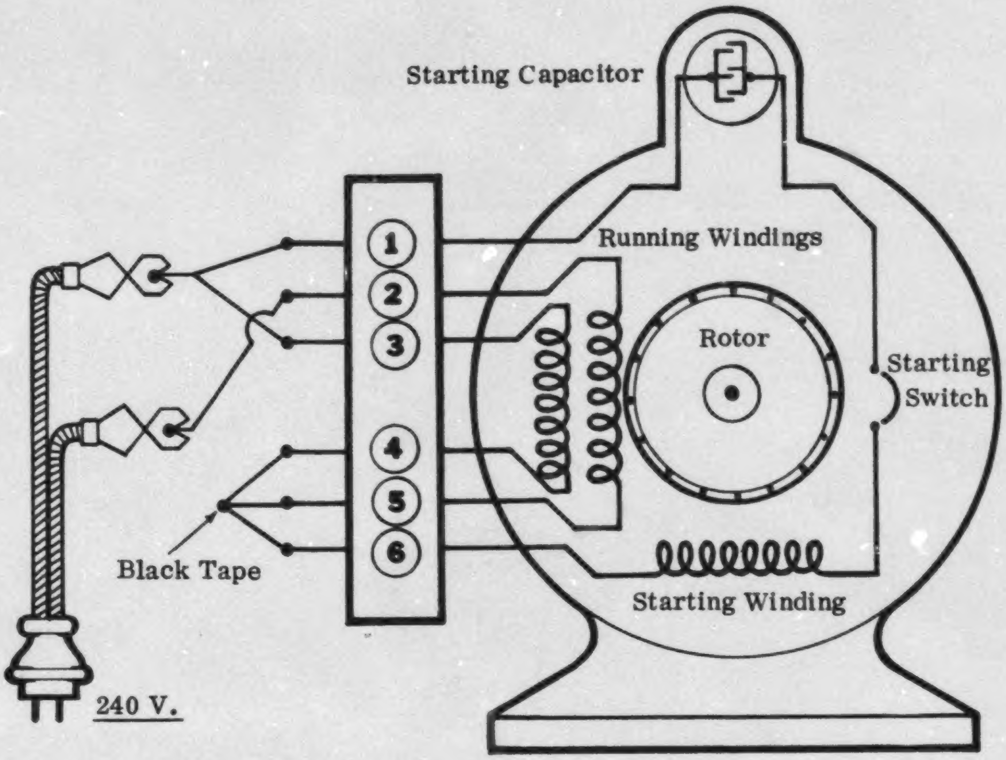
Circuit diagrams for dual-voltage capacitor-start motor wired to operate on 240 V. in one direction.

L. Plug the power lead into a 240 volt outlet.
NOTE: If the motor does not run properly, disconnect one running winding at both ends and switch.

M. To reverse the direction of rotation, switch the ends of the two running windings (in relation to starting winding) at the power lead.

N. Plug the power lead into a 240 volt electrical outlet and observe the direction of rotation.

O. Unplug the power lead and allow the motor to stop.


Starting Capacitor
Running Windings
1
2
3
4
5
6
Rotor
Starting Switch
Black Tape
Starting Winding
240 V.

Circuit diagrams for dual-voltage capacitor-start motor wired to operate on 240 V. in the opposite direction.

NOTE: If a wiring diagram is shown on the motor, the diagram should be followed when changing voltage or reversing direction of rotation.

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AGRICULTURAL MECHANICS R-2d DATE ______________

SKILL SHEET - CHANGING VOLTAGE AND DIRECTION OF ROTATION ON REPULSION - START ELECTRIC MOTORS

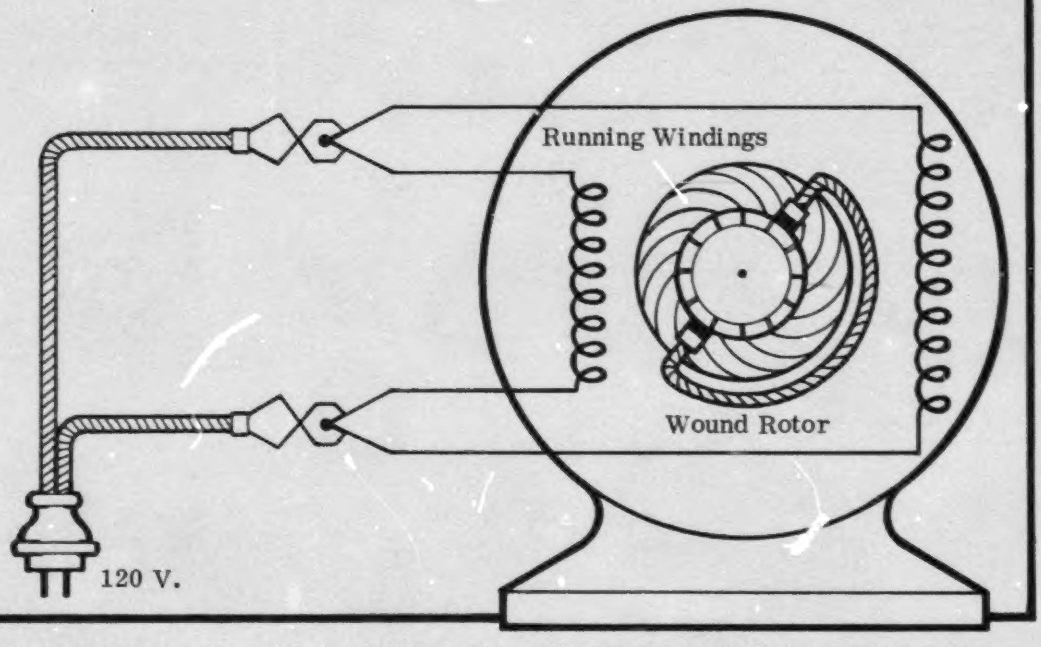
Materials Needed:

Repulsion-start electric motor (dual-voltage)
Socket wrench set
Screwdriver
Continuity test lamp and black electrical tape
Power lead with male plug and insulated clips

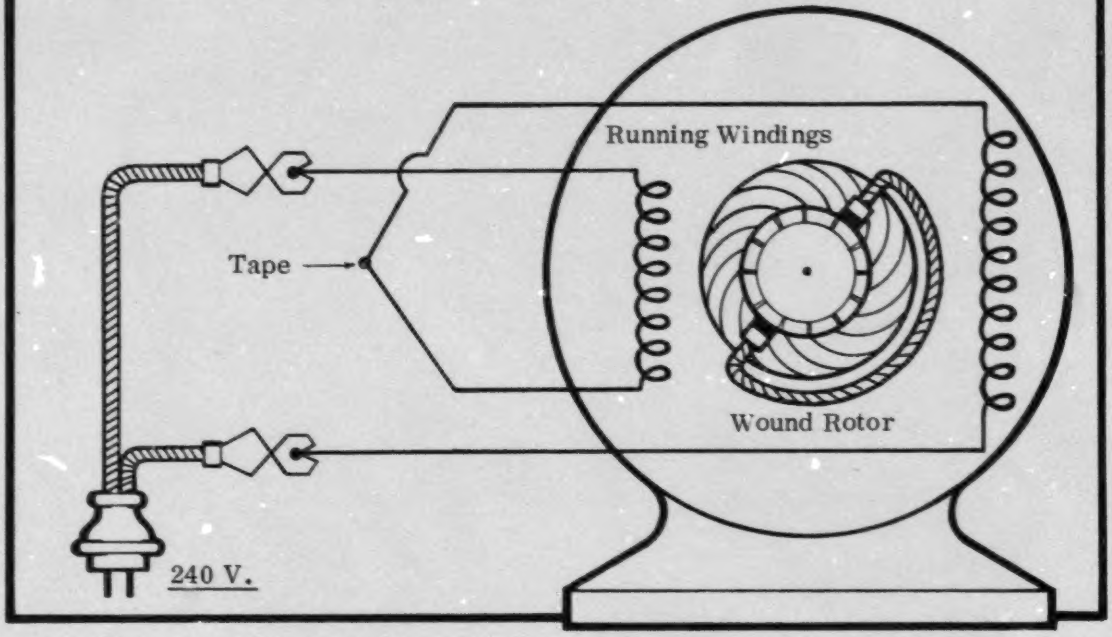
Procedure and Illustration:

A. Remove motor terminal plate.
B. Check for continuity and shorts with the test lamp.
C. Identify the two running windings with the test lamp.
D. To operate the motor on 120 volts, connect one end of each of the windings to one power lead, and the other ends to the other power lead. NOTE: If only a "hum" is heard, disconnect from the power source and switch ends of one of the windings and reconnect. The motor should run.

Circuit diagram for a dual-voltage repulsion-start motor



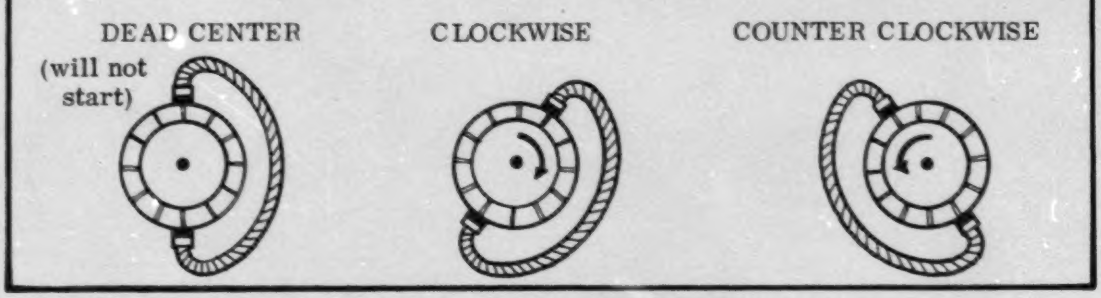
E. To operate the motor on 240 volts, connect one end of each of the windings to the power leads and join and tape the other ends together. NOTE: If the motor does not run properly when energized, switch the ends of one of the windings. (Also, check the position of the brush ring.)



Circuit diagram for a dual-voltage repulsion-start motor

F. To reverse the direction of rotation of the motor, disconnect from the power source and loosen the set screw on the brush ring.

G. If a clock-wise direction of rotation is desired, move the brush holder clockwise to the "mark" and fasten the set screw. A counter-clockwise rotation may be achieved by moving the brush holder counter-clockwise to the "mark".



Setting of brush ring on repulsion-start motor to determine direction of rotation.

NOTE: Brushes set midway between positions for clockwise and counter-clockwise will be on what is known as "dead center". In this position the motor will "hum" but will not rotate.

NOTE: Check the effect of the brush setting on the starting torque of the motor. By shifting the brushes too little or too much, the starting torque will be reduced and the motor may not come up to full speed.

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Student ______________________ School ______________________
Agricultural Mechanics T-la Date ______________________

SKILL SHEET - DIFFERENTIAL LEVELING

Materials Needed:

Tripod level	Field note page
Rod	Pencil
A prepared site for laboratory practice	

Directions: Read the following information, study the example elevation problem, and complete a differential leveling exercise in the field as directed by the instructor.

I. Glossary of Terms

A. Differential Leveling - the process of determining the differences in elevation between points without regard to alignment.

B. Starting Point - a point of known elevation (bench mark, BM) or an unknown but assumed elevation (temporary bench mark, TBM).

C. Back Sight (BS) - a rod reading on a point of known or assumed elevation.

D. Height of Instrument (HI) - the elevation of the line of sight above a datum or reference surface.

E. Fore Sight (FS) - a rod reading on a point of unknown elevation.

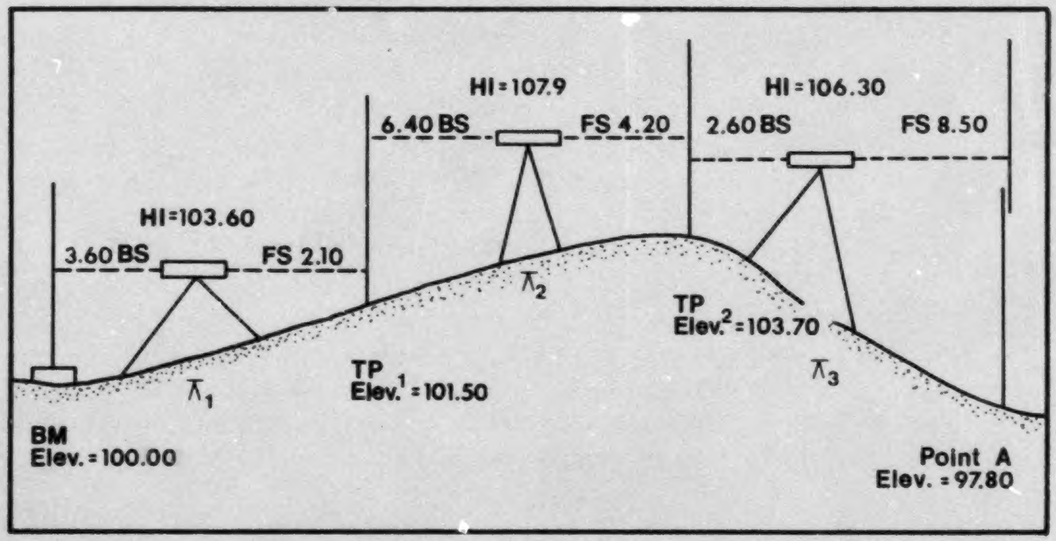
F. Turning Point (TP) - a stable point, first of unknown elevation and then known elevation, used to carry forward a line of levels.

G. Double Rod Leveling - simultaneous differential leveling.

H. Instrument Operator - the person responsible for using the tripod level and keeping field notes.

I. Rodman - the person responsible for positioning the rod.

II. Example Differential Level



III. Field Notes on Example Differential Level

STATION	BS(+)	HI	FS(−)	ELEVATION	REMARKS
BM	3.60			100.00	
⊼$_1$		103.60			
TP$_1$	6.40		2.10	101.50	
⊼$_2$		107.90			
TP$_2$	2.60		4.20	103.70	
⊼$_3$		106.30			
POINT A			8.50	97.80	

The difference in elevation between the bench mark and point A can be determined by subtracting the sum of the fore sights from the sum of the back sights. If the result is negative, as in this example (-2.20), then the final point (point A) is lower than the beginning elevation (BM).

NOTE: A plus sign (+) is entered in the heading of the B.S. column because B.S. is always added to elevation to find H.I. A negative sign (-) appears in the F.S. column because the F.S. is always subtracted from H.I. to find elevation.

IV. Procedure and Explanation of the Example Differential Level

A. The instrument man notes that the elevation of the bench mark is established at 100.00 feet.

B. The instrument man sets up and levels the instrument a suitable distance away from the bench mark in the direction toward the new point (Point A). Sighting distance should not be so great as to make it impossible to read the rod accurately. Maximum distance for most levels for good accuracy is 150 to 200 feet.

C. The instrument man makes a backsight reading of 3.60 feet on the rod which is held plumb on the bench mark by the rodman. After taking the reading, the instrument man checks the bubble again to assure himself that it remained centered while he was taking the reading.

D. The reading is entered in his notes in the BS column. To obtain the height of instrument (HI), the BS reading is added to the bench mark elevation of 100.0 feet. He then enters the value of 103.60 feet in the HI column. He gives the "all right" signal which the roadman recognizes as his cue to move to a new point along the route of survey.

E. The rodman moves the rod toward Point A, the maximum distance limited by the accuracy required and the change in elevation limits due to rod length. He places the rod on a solid spot on the ground making sure that the front face of the rod is plainly visible to the instrument man.

F. The instrument man aligns the telescope toward the rod, focuses, and checks to see that the level bubble is centered. He takes a foresight reading of 2.10 feet on the rod and rechecks the level bubble. Entering the reading in his notes he subtracts 2.10 feet from the height of instrument, and obtains an elevation of 101.50 feet for the first rod position which is identified as TP_1. In differential leveling, the rodman must remember that each new setting of the rod will be a turning point and the signal ... "take a turning point", is unnecessary.

G. The rodman holds the rod on TP_1 while the instrument man makes a new setup in the direction of Point A and takes a backsight of TP_1 to get the new height of instrument.

H. Steps B through G are repeated until Point A is reached and its elevation relative to the bench mark is obtained. The experienced instrument man usually will not make his calculations in the field, as described above. He will have his note keeping procedure well enough organized that he can spend his field time taking readings and entering them properly in his notes. The calculations can then be made at any later time. For the beginner, it is advised that he make the calculations as he goes, comparing each new height of instrument and elevation against his own estimate of what it should be. This procedure can be very helpful in avoiding needless mistakes such as reading the wrong foot mark on the rod. It also helps all members of the party to form a visual image of their immediate progress and accomplishments.

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Differential Leveling

STATION	BS(+)	HI	FS(-)	ELEVATION	REMARKS

DATE ____________

WEATHER CONDITIONS ____________

____

LOCATION ____________

____

Definition of BM used:

____

____

____

PARTY

⊼ ____________

∅ ____________

STUDENT ______________ SCHOOL ______________

AGRICULTURAL MECHANICS T-1b DATE ______________

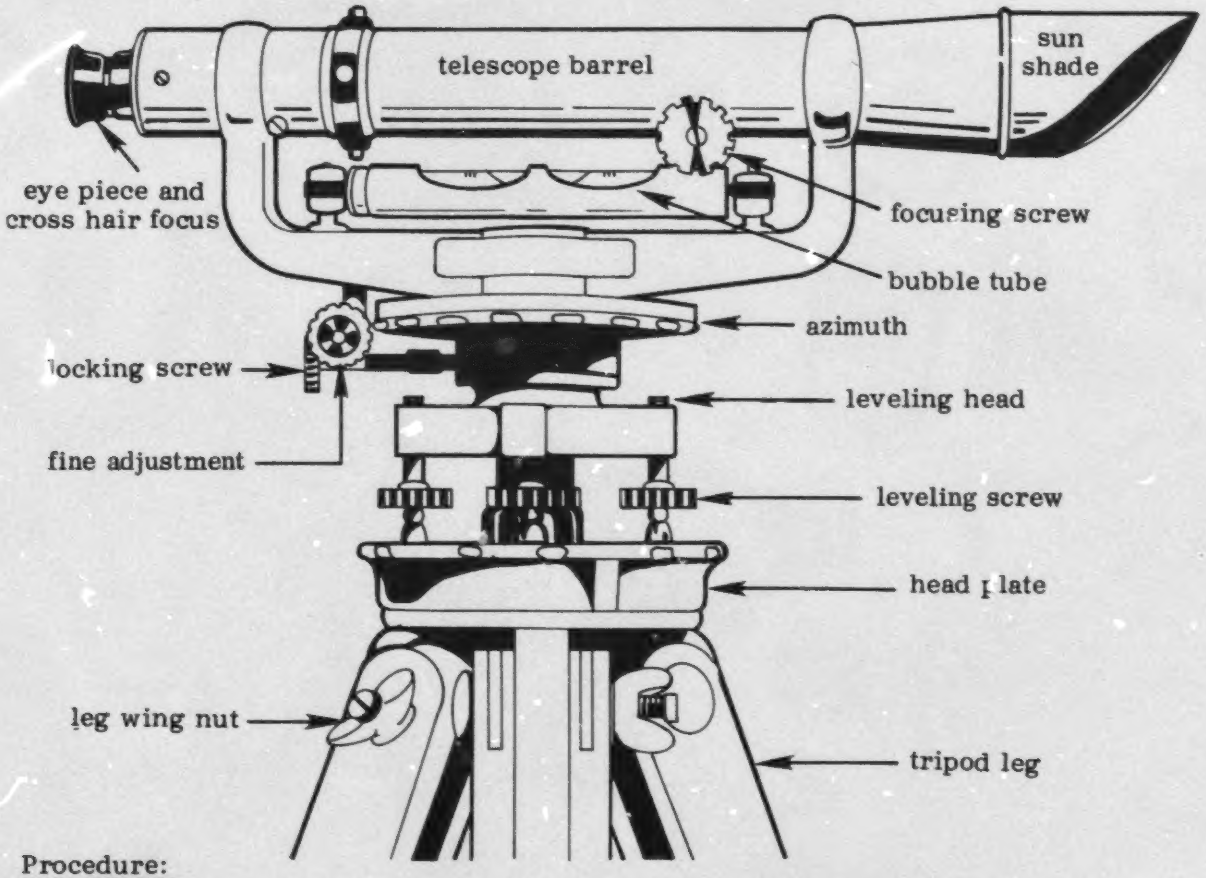
SKILL SHEET - SETTING UP AND ADJUSTING THE TRIPOD LEVEL

Materials Needed:

Tripod level
Rod

Directions: Study the parts of the level in order to become familiar with the instrument. Use the suggested procedure to set up and adjust the farm level.

Illustration of the Instrument:


telescope barrel
sun shade
eye piece and cross hair focus
focusing screw
bubble tube
azimuth
locking screw
leveling head
fine adjustment
leveling screw
head plate
leg wing nut
tripod leg

Procedure:

A. Loosen the tripod leg wing nuts, spread the legs 3 to 4 feet apart, and set the leg shoes in the ground to provide a firm stable base.
B. Visually level the head plate and tighten the leg wing nuts to maintain the position.
C. Remove the instrument from the case by holding the base to prevent damage to the telescope barrel.

D. Attach the instrument to the head plate by screwing it down.
E. Remove the lens protection cap, place it in the instrument case, and attach the sunshade to the telescope barrel.
F. Locate the rod within the limits of the instrument.
G. Level the instrument on the tripod using the four leveling screws.
    1. Rotate the telescope directly over two of the leveling screws.
    2. Grasp the two leveling screws between the thumb and forefinger of each hand and rotate the screws by bringing the thumbs toward or away from one another.
    3. Center the bubble in the tube. The bubble will move in the direction that the left thumb rotates.
    4. Rotate the telescope over the second set of leveling screws and repeat the operation.
    5. Check for accuracy by repeating the process in both positions. If the instrument is in adjustment, the telescope can be turned to any position and the bubble will remain centered.
H. Aim the telescope and adjust the eye piece until the cross hairs are in sharp focus.
I. Rotate the focusing screw to bring the target into sharp focus.
J. When focusing is completed, the rod can be read accurately.

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SKILL SHEET - LAYING OUT BUILDING LINES

Materials Needed:

Prepared site
4- 2x4 stakes
100 foot steel tape
Claw hammer
Tripod level
Plumb bob
Builder's line string
4-8d nails

Directions: Study the following methods of laying out building lines and complete a laboratory exercise using both methods.

METHOD ONE

Procedure:

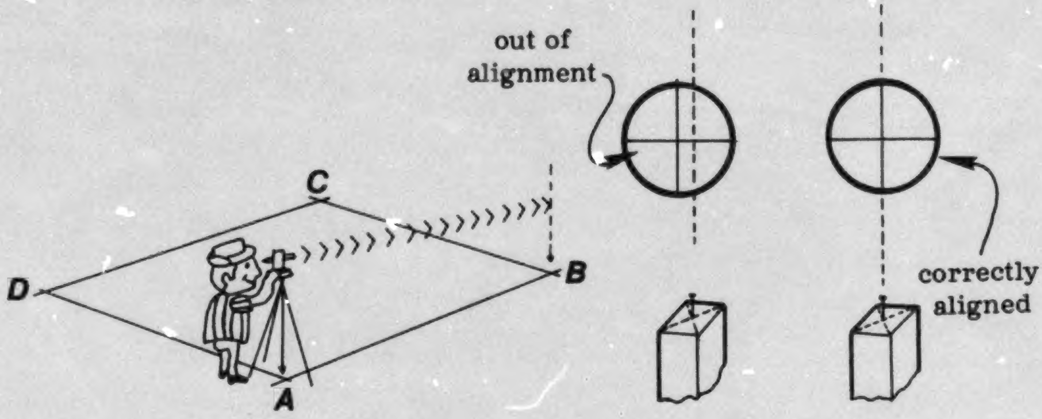
A. Locate on a prepared site one of the intended corners of the building line or foundation. Drive a stake into the ground at this point (Stake A).

B. Measure off the correct distance along one side of the foundation line and place a second stake at that point (Stake B), making sure this line parallels existing buildings, fences, or roads.

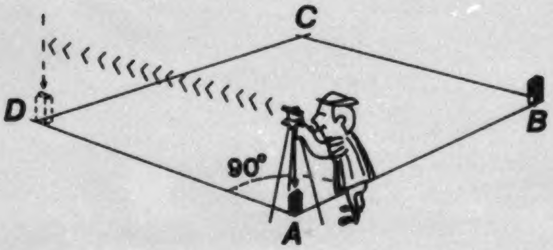
C. Draw two diagonal lines across the tops of the stakes. The intersection of these diagonal lines will locate the center of the stakes. Drive a nail part of the way into the center of the stake.

D. Attach a builder's line to the nails in the stake tops.

E. Using the plumb bob, locate the level directly over Stake A and sight to Stake B. Hold a plumb bob over the nail in Stake B and align the vertical cross hair of the level with the plumb bob string.



F. When the vertical cross hair of the level is in line with the plumb bob, set the azimuth of the level to 0 degrees. Turn the telescope exactly 90 degrees to the left and sight to Stake D.



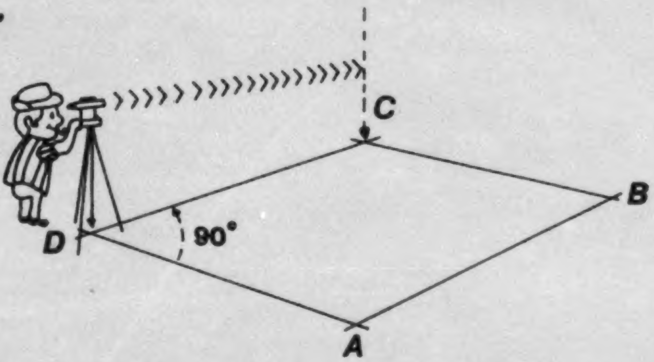
G. Measure off the correct length of the building foundation line.

H. Using the plumb bob, align the vertical cross hair to locate State D. Drive the stake at that position.

I. Drive a nail into the top center of Stake D and connect Stake A with Stake D using a builder's line.

J. To locate corner "C", use the plumb bob and position the level directly over Stake D. Sight back to Stake A and align the vertical cross hair with the plumb bob string over the center of Stake A.

K. When the vertical cross hair is in line with the plumb bob, set the azimuth of the level to 0 degrees. Turn the telescope exactly 90 degrees to the left and sight to Stake C.



L. Measure off the correct length of the building foundation line.

M. Using the plumb bob, align the vertical cross hair to locate Stake C. Drive the stake at that position.

N. Drive a nail into the top center of Stake C. Connect Stake D with Stake C using a builder's line.

O. Move the instrument to Stake C. Back sight to Stake D, then turn the telescope exactly 90 degrees to the left to sight Stake B. If the vertical cross hair is aligned with the plumb bob at Stake B, the final builder's line can be connected from Stake C to Stake B.

P. The building lines are now established and right angle batter boards can be placed at each of the four corners.

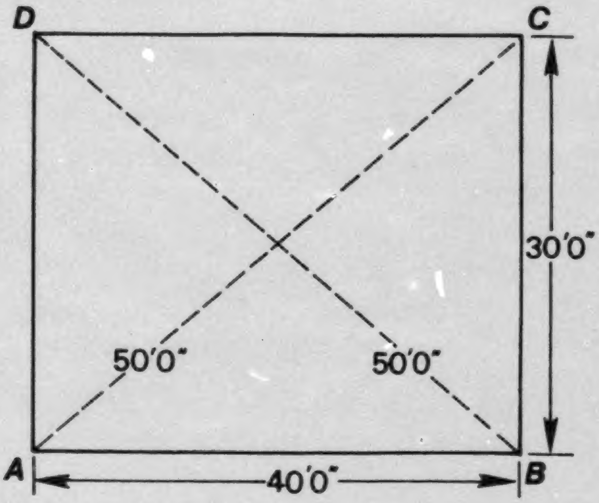
METHOD TWO

Procedure:

A. Repeat procedural steps A, B, C, and D in the preceding method.

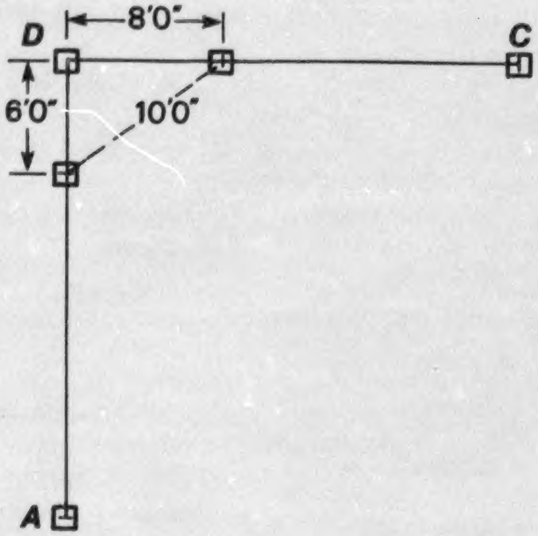
B. Establish a base rectangle encompassing the entire proposed structure by measuring along each side and staking corners "C" and "D" of the building.

C. Check the measurements of the rectangle by measuring two diagonal lines from corner to corner of the rectangle. If both diagonal measurements are the same, the building lines are correct.



D. Use a second check, the 6-8-10 method, each time a corner is established to check the accuracy of the corner angles.

1. Measure 6 feet from the corner along one building line and stake.
2. Measure 8 feet from the corner along the other building line and stake.
3. Form the third leg of the triangle by stretching a builder's line from stake to stake. The corner forms a right angle if the diagonal between the stakes measures 10 feet across.



NOTE: Use the 6-8-10 method each time a corner is established.

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AGRICULTURAL MECHANICS T-1d DATE ____________

SKILL SHEET - SETTING BATTER BOARDS FOR A FOUNDATION

Materials Needed:

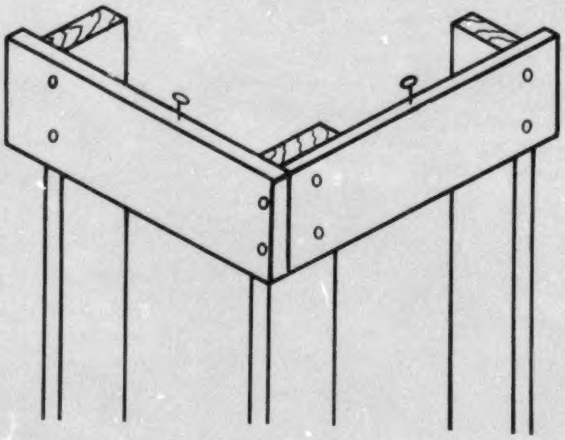
Established building lines	4 right angle batter boards
Tripod level	(8-1x6 boards and 12-2x4 stakes)
Rod	Adequate builder's line string

Directions: Complete the laboratory exercise (SKILL SHEET T-1c), LAYING OUT BUILDING LINES, and use the following procedure in setting batter boards at each corner of a proposed foundation.

Procedure:

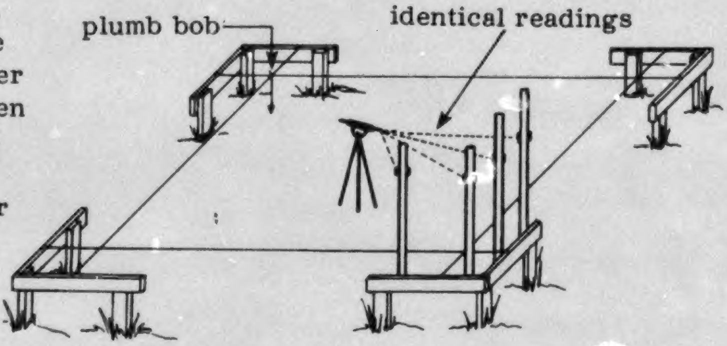
A. Batter boards are set approximately 6 feet from the corner stakes and parallel with the foundation lines. The batter boards are constructed by nailing two 1x6 boards to three 2x4 stakes. The first batter board should be set at a convenient level, usually 6 inches above the surface of the ground, and the other three batter board corners made level with it.

right angle batter board



B. If the site is fairly level, set and properly adjust the tripod level in the center of the proposed building area.

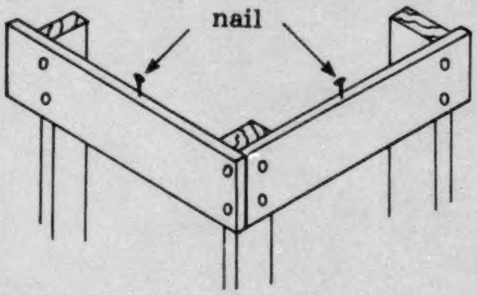
C. Fasten the batter boards to the stakes at a point slightly higher than the derived elevation, then drive the stakes carefully into the ground to bring the top of the batter boards to the proper height and make them exactly level. Determine this by taking several rod readings at several points on the batter boards as the stakes are being driven.

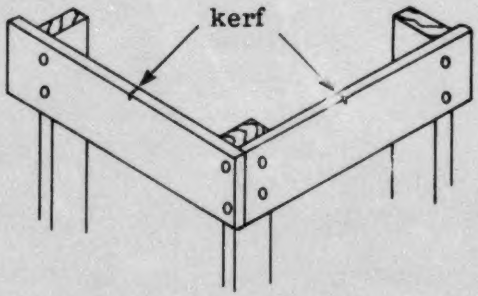


D. The batter boards may be set and leveled at the other three corners in the same manner.

E. Tie builder's line string on the batter boards to intersect directly over the four corners. Use a plumb bob to locate the intersections of the strings directly above the "X" marks on the tops of the corner stakes.

NOTE: Points of attachment for the strings on the batter boards may be marked by driving a nail or making a small saw kerf in the batter boards. This allows the strings to be removed and put up again in the correct location after the corner stakes have been removed as the foundation trenches were dug.





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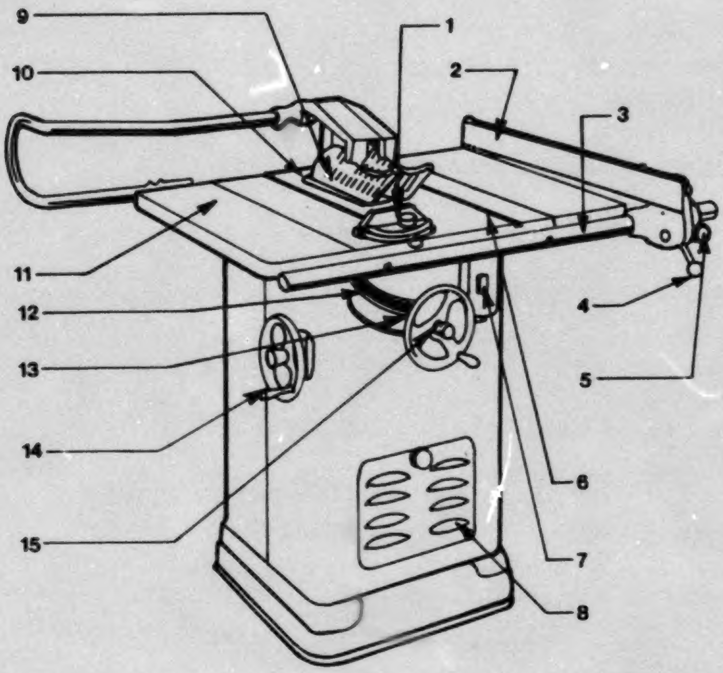
BENCH SAW SAFETY TEST

A. Parts Identification:

Identify the numbered parts of the bench saw illustrated below.



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B. True or False: (Place T or F in the blank)

_____ 1. The saw blade should be placed on the arbor with the teeth pointing in the direction from which the wood is to be fed.

_____ 2. Loose clothing, neckties, and jewelry worn while operating the bench saw can be hazardous.

_____ 3. Stock to be cut with the bench saw should be checked for nails, paint, sand, etc.

_____ 4. The operator should refrain from talking with others while sawing.

_____ 5. The operator should stand directly in line with the saw blade.

_____ 6. A push stick should be used when ripping narrow stock.

_____ 7. The miter gage and fence should be used when crosscutting.

_____ 8. Sawed-off scraps can be removed from the table top while the machine is running.

_____ 9. When crosscutting, adjust the depth of the cut so that the teeth clear the thickness of the stock by the depth of the teeth.

_____ 10. When ripping, adjust the blade to extend 1/4" to 1/2" above the stock being sawed.

_____ 11. Make sure the power source is disconnected while making adjustments or changing blades on the bench saw.

_____ 12. Always use the miter gage when crosscutting.

_____ 13. Be sure the saw guard and splitter are in place while using the bench saw.

_____ 14. Always wear eye protection and dress properly while using the bench saw.

_____ 15. The operator should be the only person inside the bench saw safety zone.

_____ 16. Saw only material that has a straight edge.

_____ 17. Be sure that all adjustments are tight and the table part of the saw is free of tools, chips, and small pieces of wood before using the bench saw.

_____ 18. The floor should be free of scraps and rubbish while working with the bench saw.

_____ 19. Non-skid materials are recommended for the floor in front of the bench saw.

_____ 20. Free-hand sawing can be done while the instructor supervises the work.

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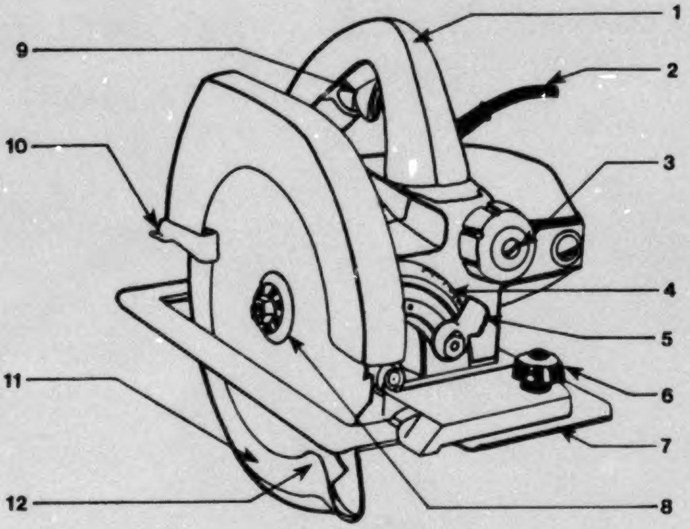
PORTABLE CIRCULAR SAW SAFETY TEST

A. PART IDENTIFICATION:

Identify the circled parts on the portable circular saw illustrated below.



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B. True or False: (Place T or F in the blank)

_____ 1. Change blades and make saw adjustments while the saw is connected to the power source.

_____ 2. Check all adjustment thumbscrews to be sure they are tight and set correctly before operating the saw.

_____ 3. The direction of blade rotation does not affect installation of the saw blade.

_____ 4. Dull blades are unsafe and inefficient.

_____ 5. Eye protection and proper dress need not be considered when operating the saw for short periods of time.

_____ 6. Be sure the saw is operated only in a safety grounded circuit.

_____ 7. Care should be taken in determining the location of the power cord at all times to avoid cutting it.

_____ 8. The saw can be pulled across the floor by use of the power cord.

_____ 9. The blade should be in contact with the material to be cut when the saw is started.

_____ 10. Be sure the material to be cut is properly supported in order for the work to be solidly placed and to prevent cutting into the supports.

_____ 11. It is proper to cut materials between two supports or saw horses.

_____ 12. The depth of the cut should be adjusted so that the teeth clear the thickness of the material by the depth of the teeth.

_____ 13. Saw only in a forward direction and stand in a safe position.

_____ 14. Allow the saw blade to stop before setting the saw on the floor or work bench.

_____ 15. Be sure the retractable blade guard moves freely before using the saw.

_____ 16. Both hands should be used to hold and guide the saw.

_____ 17. Check the material to be cut and be sure it is free of nails and loose knots.

_____ 18. The operator can safely reach over or around the saw while it is running.

_____ 19. If the blade binds while ripping, a wedge may be placed in the saw kerf to give clearance.

_____ 20. When the end of the cut is reached, release the trigger switch and allow the blade to follow through as the saw is lifted away from the work.

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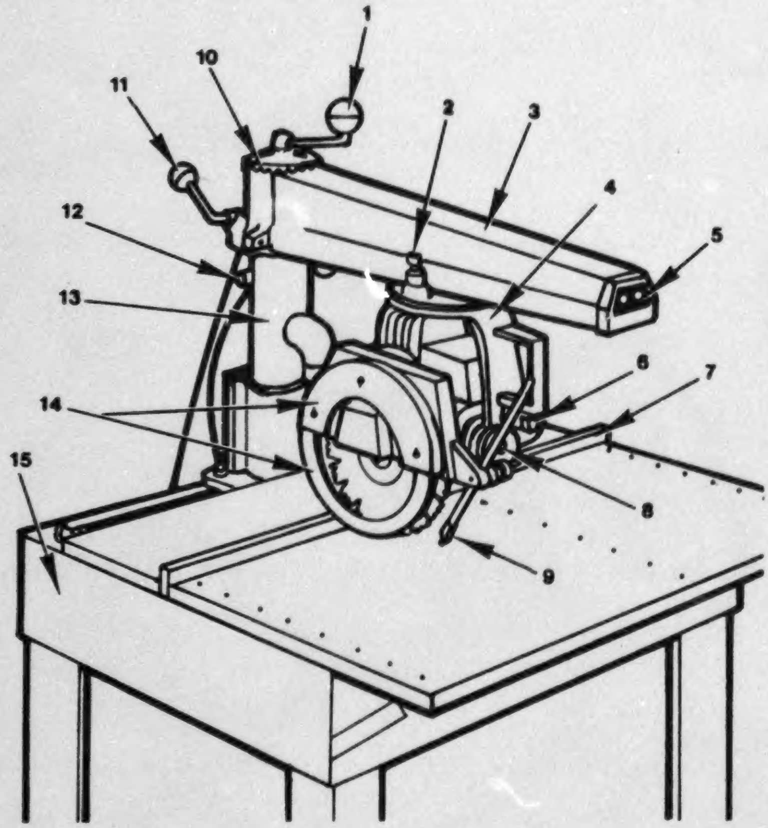
RADIAL ARM SAW SAFETY TEST

A. PART IDENTIFICATION:

Identify the circled parts on the radial arm saw illustrated below.



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B. True or False: (Place T or F in the Blank)

_____ 1. When changing blades, place the blade on the arbor so that the teeth on the bottom of the blade point back or toward the elevating column.

_____ 2. To stop the machine, force a piece of wood against the blade.

_____ 3. Check the lumber for nails, screws, and loose knots before sawing.

____ 4. Be certain that all clamps, guards, and locking handles are securely tightened before sawing.

____ 5. The saw should be pushed to the rear of the table and locked in place when not in use.

____ 6. Before starting the saw, be sure that the blade is not in contact with the material to be cut.

____ 7. Loose clothing and safety glasses are a must when using the radial arm saw.

____ 8. A crosscut blade can be safely used when ripping.

____ 9. In ripping operations, the stock is fed into the saw against the direction of the blade rotation.

____ 10. The stock should be removed from the table before pushing the blade to its original position.

____ 11. In crosscutting operations, press the stock against the fence, hold it with the left hand, and pull the saw handle with the right hand.

____ 12. Stop the saw and remove scraps from the table top with a stick.

____ 13. The table top is an excellent place to keep the square and tape during sawing operations.

____ 14. The radial arm saw can be safely adjusted while it is running.

____ 15. The floor in front of the saw table should be treated with an anti-skid material.

____ 16. The saw should be left running while measuring and marking materials for sawing.

____ 17. A table extension or roller support is necessary when working with long material.

____ 18. When ripping, use a push stick when working near the blade.

____ 19. When crosscutting, pull the saw toward the operator at a slow even speed to prevent grabbing.

____ 20. Do not use the radial arm saw without permission from the instructor.

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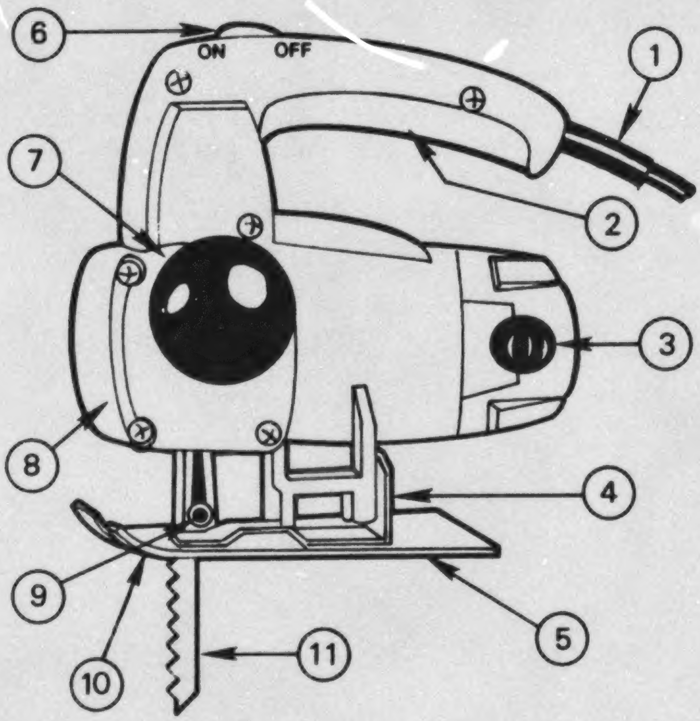
SABRE SAW SAFETY TEST

A. PART IDENTIFICATION:

Identify the circled parts on the sabre saw illustrated below.



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B. TRUE OR FALSE: (Place T or F in the blank)

_____ 1. Safety glasses are not needed while using the sabre saw.

_____ 2. Loose clothing should not be worn when operating the sabre saw.

_____ 3. A clean work area free from obstructions and debris should be maintained during operation of the sabre saw.

_____ 4. The stock should be secured with a bench vise or clamp to free both hands to operate the saw.

_____ 5. The stock should be clamped securely to prevent movement or excessive vibration.

______ 6. The line of cut must be free from obstructions above and below the work.

______ 7. Be sure the saw is operated only in a safety grounded circuit.

______ 8. Start the cut by placing the blade against the edge of the work and starting the motor.

______ 9. One tooth should be in contact with the cutting surface at a time.

______ 10. Exert a constant, firm pressure on the saw to maintain a uniform forward movement.

______ 11. The cut-off section of stock should be supported to prevent binding the blade.

______ 12. The handle should be gripped firmly with the right hand and turning movements should be controlled with the left hand on the guide knob.

______ 13. If the saw is to be removed from the cut prior to reaching the edge of the work, turn off the motor and wait until the blade stops before removing the saw from the cut.

______ 14. The saw may be set down on the floor or work bench before the blade stops.

______ 15. Overloading the saw by cutting too fast may overheat the motor or damage the blade.

______ 16. Any adjustments to be made to the saw should be done with the motor running.

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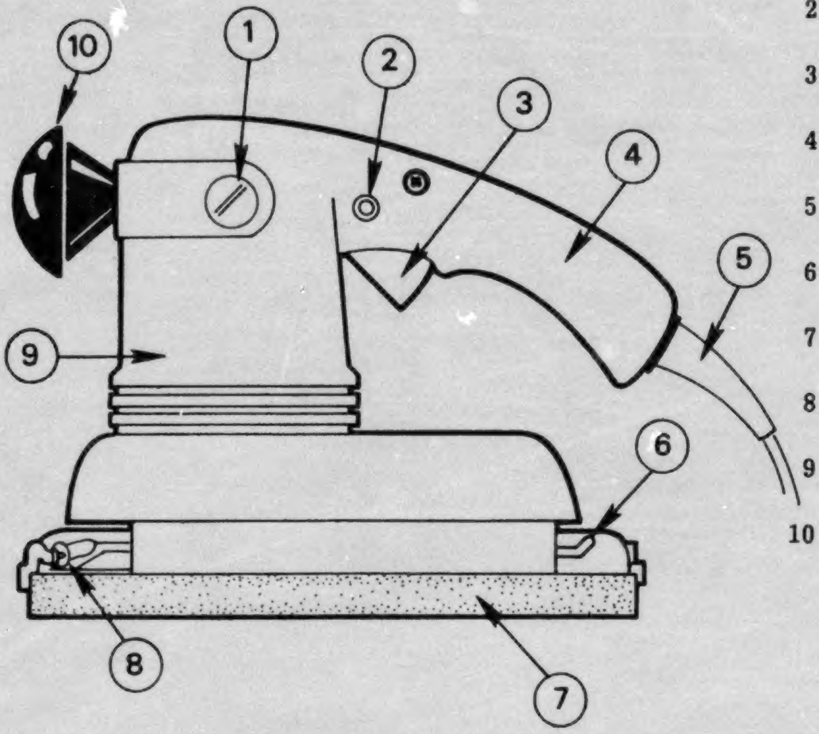
FINISHING SANDER SAFETY TEST

A. PART IDENTIFICATION:

Identify the circled parts on the finishing sander illustrated below.



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B. TRUE OR FALSE: (Place T or F in the blank)

_____ 1. The finishing sander may have an orbital stroke or a straight-line stroke.

_____ 2. It is not necessary for the operator to wear safety glasses.

_____ 3. Stock to be sanded should be clamped in a vise or to the work table.

_____ 4. Press downward on the sander to make the sanding cut faster.

_____ 5. Usually the weight of the machine is enough pressure to keep the sander cutting.

_____ 6. Sanding should be done across the grain.

_____ 7. Clamp the paper securely with sufficient tension across the pad.

_____ 8. When sanding is completed, lift the sander off the work before stopping the motor.

_____ 9. Be sure the sander is operated only in a safety grounded circuit.

_____ 10. Adjustments to the sander should be made only when it is disconnected from the power source.

_____ 11. To start the sander, set it in place on the stock to be finished and start the motor.

_____ 12. The finishing sander is generally operated with one hand.

_____ 13. The grade or coarseness of the paper used is not related to the work to be done.

_____ 14. Torn paper can cause damage to the pad.

_____ 15. Before storing the sander, remove the sandpaper and thoroughly clean dust and other material from the machine.

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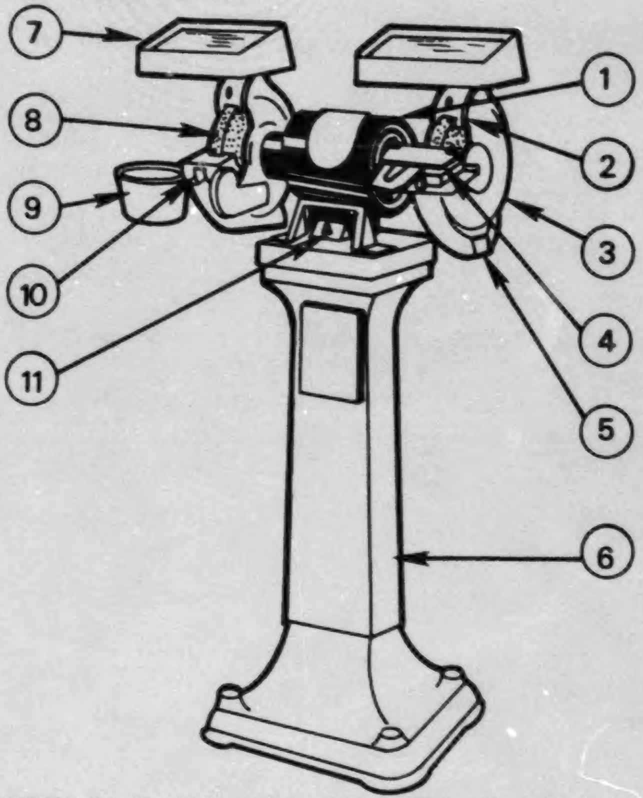
GRINDER SAFETY TEST

A. PART IDENTIFICATION:

Identify the circled parts on the grinder illustrated below.



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B. TRUE OR FALSE: (Place T or F in the blank)

_____ 1. Wear a face guard even though the grinder has a glass safety shield.

_____ 2. Adjust the tool rest so that it is 3/8 inch from the face of the grinding wheel.

_____ 3. The wheel dresser should be used for straightening a grooved, rounded, or out-of-round grinding wheel.

_____ 4. If the grinding wheel is larger than the wheel guard housing, remove the housing to operate the grinder.

_____ 5. Match the specifications for the grinding wheel with the grinder and the work to be done.

______ 6. The glaze on the wheel after grinding soft metal can be removed with the wheel dresser.

______ 7. The grinding wheel should be used until it is worn down to 1/4 of its original diameter.

______ 8. Using the side of the grinding wheel may place stress on the wheel, causing it to break.

______ 9. The grinder should reach full speed before it is used.

______ 10. Hold material to be ground in a way that the fingers will not come in contact with the wheel.

______ 11. The wheel may be stopped by forcing a piece of scrap metal into the face of the wheel.

______ 12. It is necessary to remove the paper on each side of a new grinding wheel.

______ 13. When sharpening a tool, it may be dipped in water to prevent overheating.

______ 14. The operator should never leave the safety zone until the grinder is turned off and wheel stops turning.

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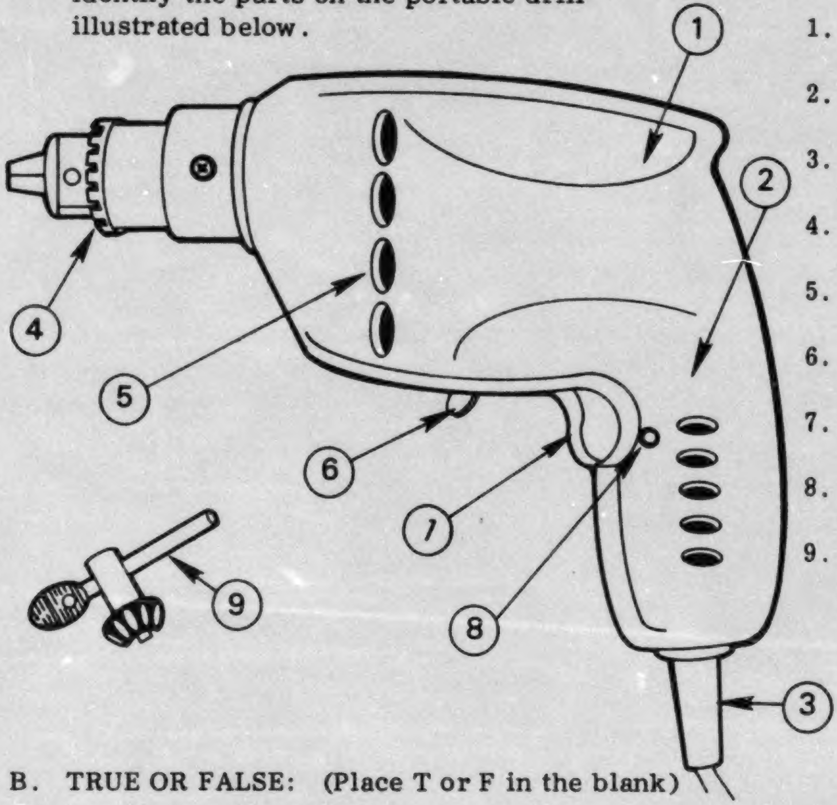
PORTABLE DRILL SAFETY TEST

A. PART IDENTIFICATION:

Identify the parts on the portable drill illustrated below.



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B. TRUE OR FALSE: (Place T or F in the blank)

_____ 1. Sleeves should be rolled up; ties, watches, and rings should be removed; and safety glasses should be worn while operating the electric drill.

_____ 2. Be sure the drill is double insulated or safety grounded before operating it.

_____ 3. Never operate the portable drill while standing in water or on a wet floor.

_____ 4. The drill should be pulled across the floor by the power cord.

_____ 5. Use the forefinger to brush chips from around the twist drill.

_____ 6. Always lock the switch in the on position when using the portable drill.

_____ 7. The twist drill will not run true if the chuck is not properly tightened.

_____ 8. Stock should be securely fastened to prevent twisting during the drilling process.

_____ 9. The center of the hole to be drilled should be marked with a center punch or awl.

_____ 10. Drill with even, steady pressure and let the drill do the work.

_____ 11. When drilling deep holes, withdraw the drill several times to clear out the cuttings or chips.

_____ 12. Position the power cord so as not to drill into it or get it wrapped around the twist drill.

_____ 13. When using a large drill, brace the body well to prevent injury.

_____ 14. Twist drills are made and sharpened to cut in a clockwise direction.

_____ 15. Power should be disconnected and the twist drill removed as soon as work is completed.

_____ 16. It is permissible to operate the portable drill with the chuck key in the chuck.

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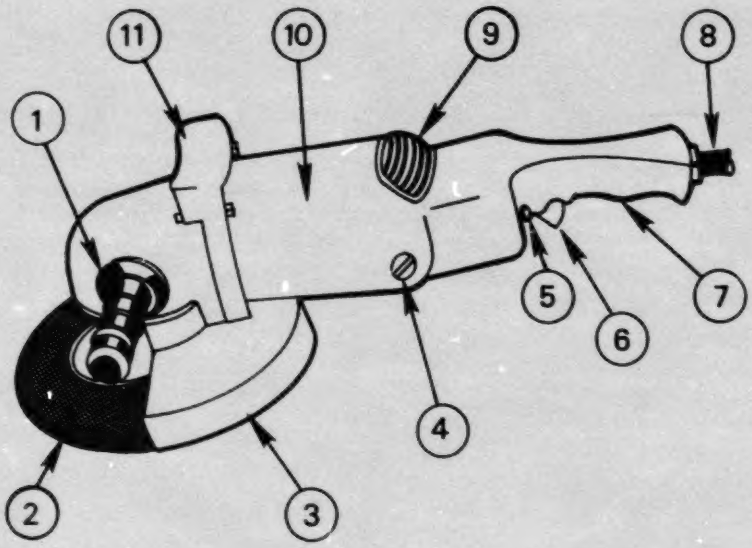
PORTABLE SANDER - GRINDER SAFETY TEST

A. PART IDENTIFICATION:

Identify the circled parts on the portable sander - grinder illustrated below :



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B. TRUE OR FALSE: (Place T or F in the blank)

_____ 1. The sander-grinder should be held with both hands when in use.

_____ 2. A face shield, safety glasses, and proper dress are necessary while operating or observing the sander-grinder.

_____ 3. If the sparks are discharged toward someone, small pieces may become embedded in the skin or may cause burns.

_____ 4. It is permissible to operate the sander-grinder on a wet floor if it is safety grounded.

_____ 5. The sander-grinder should be placed on its rest so that nothing touches the abrasive disc while not in use.

_____ 6. It is permissible to lay the grinder down while the disc is turning.

_____ 7. The grinder speed should not exceed the speed stamped on the abrasive disc.

_____ 8. The power should be disconnected before making adjustments or changing discs.

_____ 9. Be sure small stock is clamped securely before grinding.

_____ 10. Using the sander-grinder near flammable materials should be avoided.

_____ 11. The power cord is insulated so that it will not be damaged if it comes in contact with the abrasive disc.

_____ 12. Discontinue use of the abrasive disc when it is cracked or becomes worn to less than 1/2 of its original diameter.

_____ 13. Feed the abrasive disc lightly into the work after the motor has come up to full speed.

_____ 14. When selecting the abrasive disc, match the disc with the work and the grinder.

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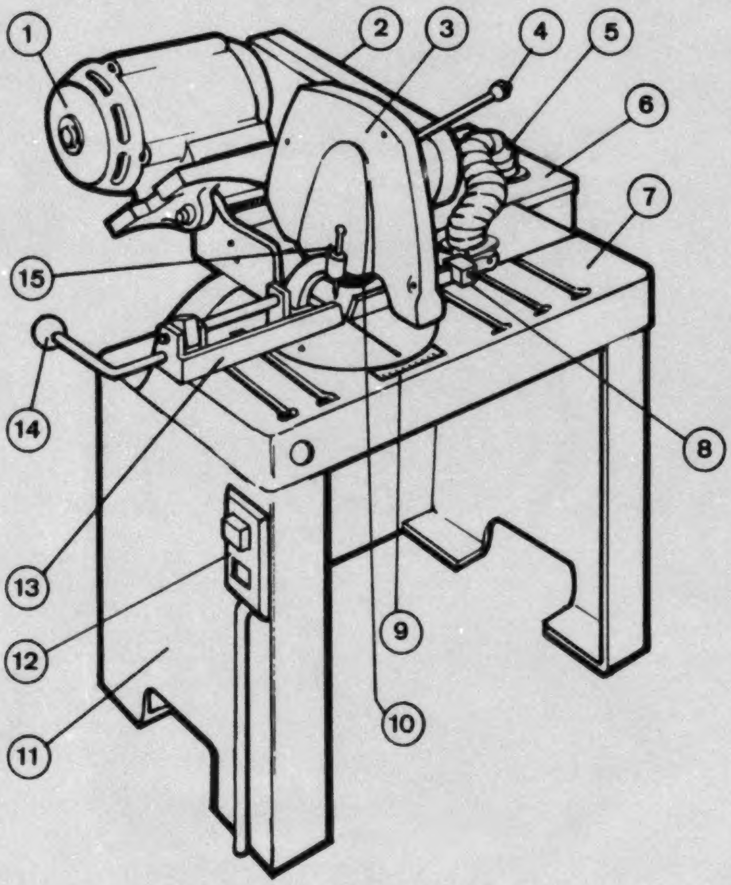
ABRASIVE CUT-OFF MACHINE SAFETY TEST

A. PART IDENTIFICATION:

Identify the circled parts on the abrasive cut-off macnine illustrated below:



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B. TRUE OR FALSE: (Place T or F in the blank)

____ 1. Safety glasses and a face shield should be worn by the operator and all observers while using the abrasive cut-off machine.

____ 2. The work area should be clean and free from scrap material.

____ 3. Cut-off stock becomes extremely hot and should be handled carefully.

_____ 4. Long stock should be supported while cutting.

_____ 5. The machine should not be disconnected from the power source while changing wheels or making adjustments.

_____ 6. Using the feed handle, the operator should jerk the wheel onto the stock and make the cut as fast as possible.

_____ 7. The work clamp should be adjusted to properly position the stock and hold it securely against the fence.

_____ 8. The size of the cut-off machine is determined by the diameter of the abrasive wheel.

_____ 9. The operator should remain in the safety work zone until the machine is turned off.

_____ 10. The dust collector should be used to prevent dust, grit, shavings, etc. from contaminating the air.

_____ 11. The cut-off machine can replace the metal hacksaw and band saw in performing precision work.

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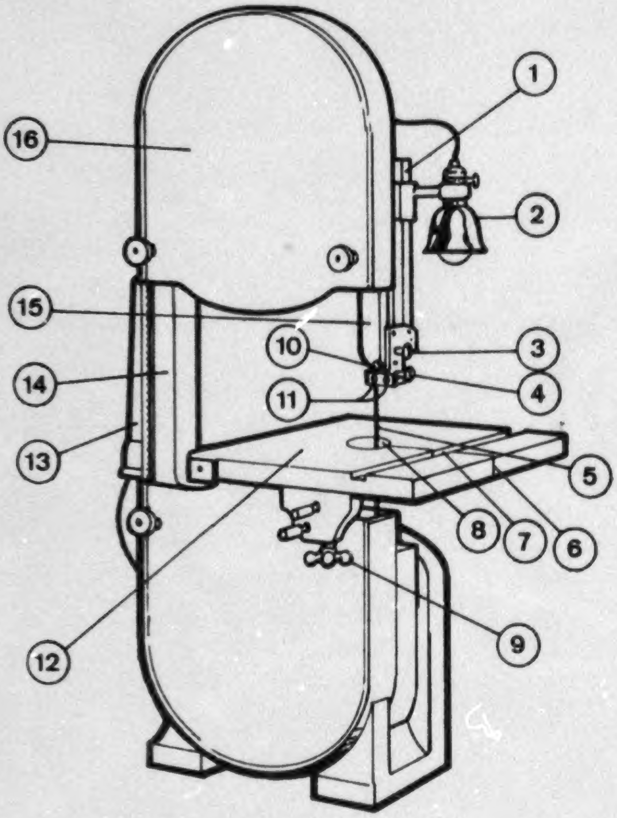
BAND SAW SAFETY TEST

A. PART IDENTIFICATION:

Identify the parts on the band saw illustrated below:



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B. TRUE OR FALSE: (Place T or F in the blank)

_____ 1. Safety glasses and loose fitting clothing are a must when operating the band saw.

_____ 2. Adjust the upper blade guards and guide to 1/4" above material to be cut.

_____ 3. Before using the band saw, check all adjustments with the power connected.

_____ 4. The cutting radius is the same for any width of band saw blade.

_____ 5. The blade should be installed and properly tensioned with the teeth pointing downward in the direction of blade travel.

_____ 6. The saw blade should be adjusted so that it will run on the center of the wheels and straight through the guides.

_____ 7. Lumber having loose knots, nails, or other foreign materials can be safely cut on the band saw.

_____ 8. The saw should operate with a blade speed of 3000 feet per minute when cutting wood.

_____ 9. Always turn off the machine and allow the blade to stop before backing out of a cut.

_____ 10. The stock should be fed slowly into the saw being careful not to twist the blade or produce excess stress on the blade.

_____ 11. Use one hand to guide and the other hand to push the stock when freehand sawing.

_____ 12. Chips and scraps can be removed safely from the table with the blade moving.

_____ 13. Hands should never be closer than 2" from the moving blade.

_____ 14. The operator should be the only person inside the safety zone and should never leave the zone until the machine is completely stopped and power disconnected.

_____ 15. A miter gage can be used to make straight cuts.

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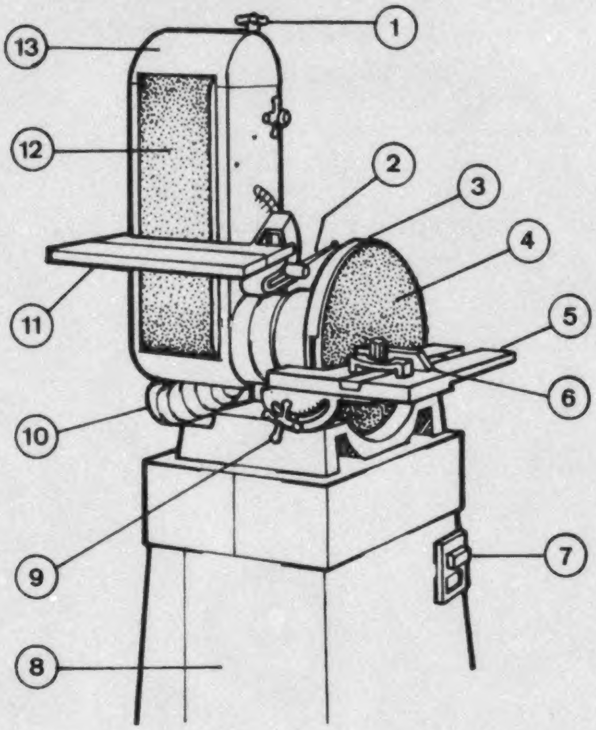
AGRICULTURAL MECHANICS DATE ______________

ABRASIVE BELT-DISC SANDER SAFETY TEST

A. PART IDENTIFICATION:

Identify the circled parts on the abrasive belt-disc sander illustrated below:



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B. TRUE OR FALSE: (Place T or F in the blank)

_____ 1. Safety glasses and tight fitting clothing should be worn when operating the sanding machine.

_____ 2. The table should be adjusted so that the edge is 1/8" from the disc or belt.

_____ 3. Adjustments except for belt alignment should be made with the power disconnected from the machine.

_____ 4. Sanding should be done on the side of the disc that is moving toward the table.

_____ 5. Excessive pressure of the stock against the disc or belt will not overload the motor.

_____ 6. Be sure to keep hands and fingers away from the disc and belt.

_____ 7. The size of the machine is determined by the width of the belt and the diameter of the disc.

_____ 8. Place the stock in contact with the disc or belt before turning the motor on.

_____ 9. The operator should remain in the safety zone until the motor has completely stopped and the power is disconnected.

_____ 10. It is permissible to sand with a belt or disc that is torn or slightly loose.

_____ 11. Move the stock sideways, back and forth slightly, to reduce the heat caused by friction between the disc or belt and the edge of the stock.

_____ 12. Be sure the machine is operated in a safety grounded circuit, with all guards in place, and the work area kept clean.

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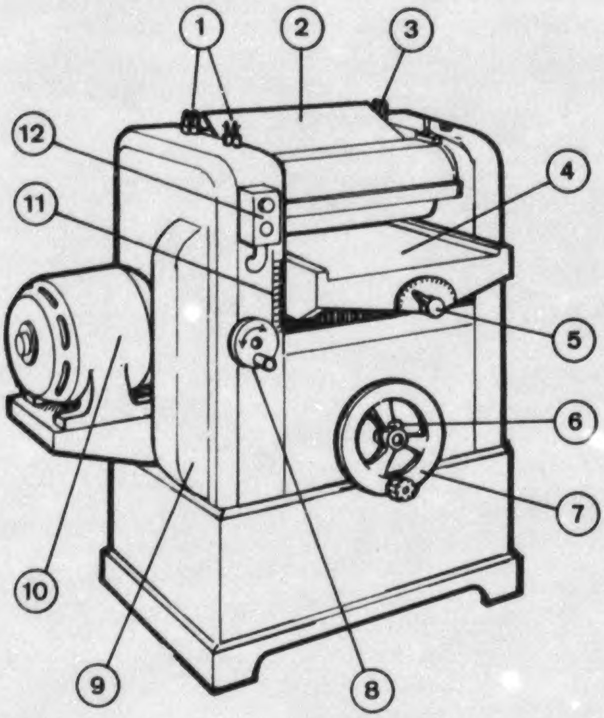
PLANER SAFETY TEST

A. PART IDENTIFICATION:

Identify the circled parts on the planer-surfacer illustrated below.



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B. TRUE OR FALSE: (Place T or F in the blank)

______ 1. Eye protection should be worn at all times while the planer is in operation.

______ 2. Adjustments should be made while the machine is running.

______ 3. Knives should be sharp and properly adjusted.

______ 4. The floor and work areas should be free of chips, wood scraps, and obstructions.

_____ 5. Material may be fed into the planer before the motor is at full RPM.

_____ 6. Always stand to one side when feeding or receiving stock.

_____ 7. It is recommended to remove no more than 1/8" on softwoods or 1/16" on hardwoods during one pass.

_____ 8. Loose knots and nails need not be removed prior to planing.

_____ 9. Turn the machine off and lower the table bed to remove stock stuck in the machine.

_____ 10. Hands should be kept away from feed rolls and knives, and do not attempt to plane stock shorter than 12".

_____ 11. Use a backer board when planing stock to a thickness of less than 3/8".

_____ 12. Do not leave the safety zone until the motor is stopped and the power disconnected.

_____ 13. It is permissible to plane wet lumber without lubricating the table bed.

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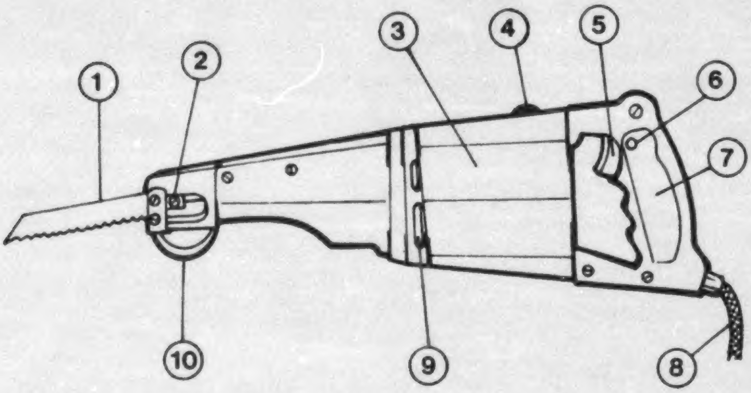
RECIPROCATING SAW SAFETY TEST

A. PART IDENTIFICATION:

Identify the circled parts on the reciprocating saw illustrated below.



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B. TRUE OR FALSE: (Place T or F in the blank)

_____ 1. Blades used for sawing metal should have 18-24 teeth per inch and be made from high speed steel.

_____ 2. Blades used for sawing wood or other soft materials should have 6-10 teeth per inch and be made of carbon steel.

_____ 3. Most reciprocating saws have two speeds, a high speed for wood and a low speed for metal.

_____ 4. Safety glasses are not necessary when using the reciprocating saw.

_____ 5. Use a double insulated saw or make sure the circuit is safety grounded.

______ 6. Be sure the rocker shoe is held tightly against the material to be cut.

______ 7. Material to be cut should be held securely with a vise or secure as constructed.

______ 8. The rocker shoe enables the operator to roll the blade into starting cuts.

______ 9. To speed the cutting, force the cut with down pressure.

______ 10. The blade should be left in the saw for storage.

______ 11. The finish side of the material should be placed face down during the cutting operation.

______ 12. Care should be taken to see that obstructions or the power cord are not in the line of the saw cut.

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JOINTER SAFETY TEST

A. PART IDENTIFICATION:

Identify the circled parts on the jointer illustrated below.

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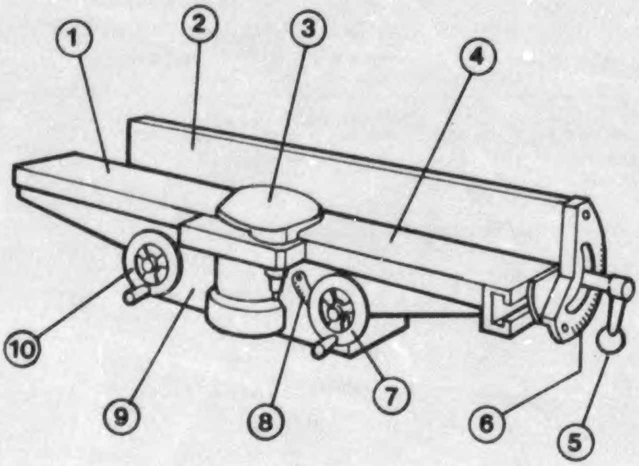

B. TRUE OR FALSE: (Place T or F in the blank)

_____ 1. The guard covering the cutterhead should be removed when jointing long stock.

_____ 2. The jointer's main function is to surface or plane lumber.

_____ 3. Dull knives may cause a kickback.

_____ 4. When knives are replaced, all knives should be replaced and sharpened as a set.

_____ 5. The front table adjusting hand wheel will adjust the depth of cut.

______ 6. The machine should never be set to cut more than 1/8" from softwoods or 1/16" from hardwoods.

______ 7. The rear table should be set exactly level with the knives in the cutterhead.

______ 8. The fence should be moved back and forth to different positions periodically so as not to cut at the same position on the cutterhead.

______ 9. All cuts should be made with the grain.

______ 10. It is not necessary to wear eye protection when operating the jointer.

______ 11. Use a push-stick with short stock or at the end of a board.

______ 12. The operator should stand directly in line with the tables.

______ 13. When working long stock, use a roller table or a helper to support the stock as it passes over the rear outfeed table.

______ 14. The stock should be jointed at a slow steady speed of about 16 feet per minute.

______ 15. Do not joint stock less than 1/2" thick or 12" long.

______ 16. Turn off the power and allow the machine to stop before leaving the safety work zone.

______ 17. Always make adjustments with the machine running.

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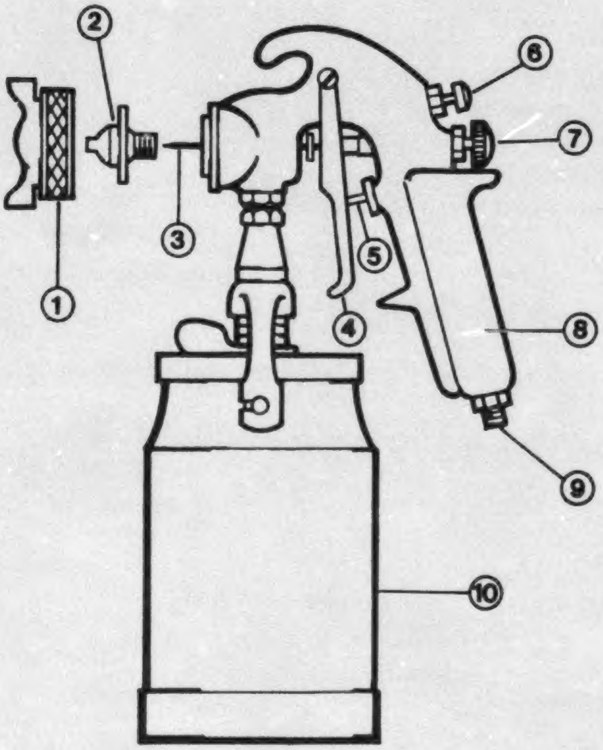
SPRAY PAINTING SAFETY TEST

A. PART IDENTIFICATION:

Identify the circled parts on the paint spray gun illustrated below:



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B. TRUE OR FALSE: (Place T or F in the blank)

_____ 1. Torches and welding equipment should not be used in the painting area or near the mixing bench.

_____ 2. Solvent and thinner containers should be kept closed and stored properly.

_____ 3. Solvent drums and electrical equipment should be grounded to avoid static electricity build-up.

_____ 4. Any type of fire extinguisher should be placed in strategic locations to control paint related fires.

_____ 5. Wash hands thoroughly before eating.

_____ 6. The paint area and aisles should be free of tools and any materials that cause tripping.

_____ 7. Safety goggles or glasses are not necessary because splashing liquid and dust are seldom a problem while sanding and painting.

_____ 8. Respirators and filter masks will aid in keeping fumes and dust from entering the lungs.

_____ 9. When handling certain metal conditioners and paint removers, rubber gloves should be worn.

_____ 10. The compressor should be located so that overspray will not be sucked into the air intake.

_____ 11. The compressor safety valve should be checked regularly.

_____ 12. Spray pressure should be adjusted according to specifications of the manufacturer.

_____ 13. After each use the entire gun should be disassembled and properly cleaned.

_____ 14. The spray gun should be held one foot from the surface to be painted.

_____ 15. The trigger should be pulled before the stroke begins when using the spray gun.

_____ 16. The paint area should have proper ventilation and lighting.

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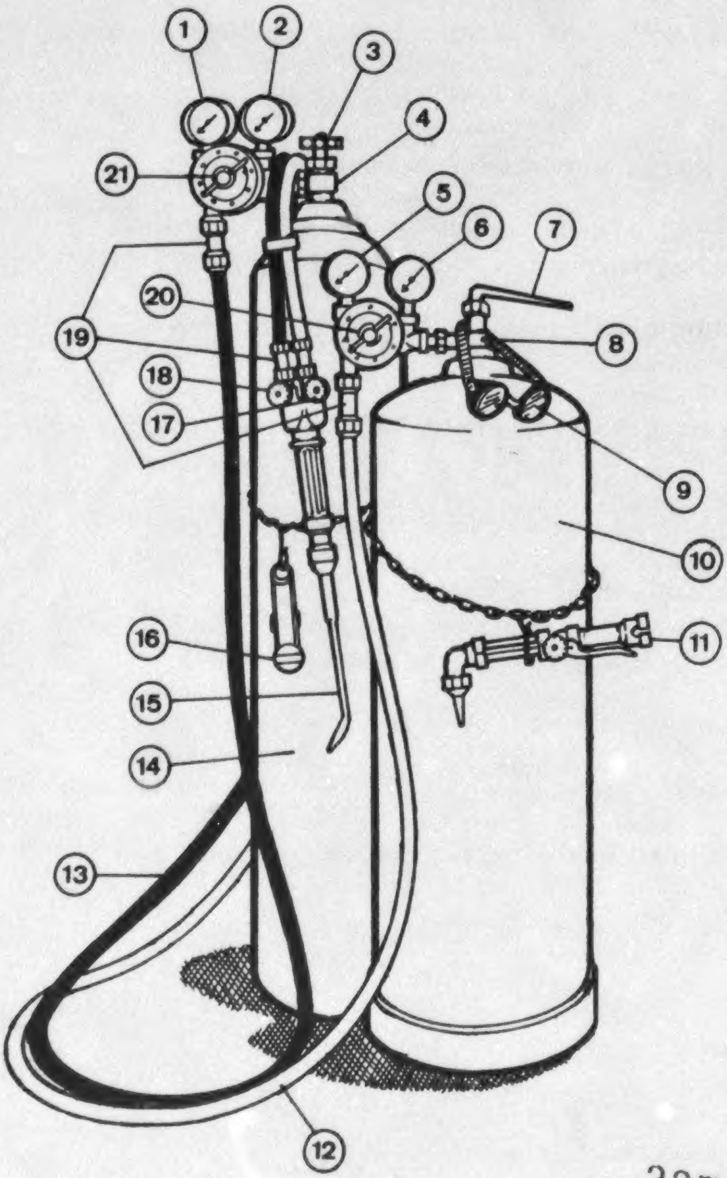
OXYACETYLENE SAFETY TEST

A. PART IDENTIFICATION:

Identify the circled parts of the oxyacetylene rig illustrated below.



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B. TRUE OR FALSE: (Place T or F in the blank)

____ 1. The cylinders should always be securely held in an upright position.

____ 2. Oil or grease may be used to lubricate fittings around the regulator.

____ 3. The regulator gauges should be pointed up toward the ceiling.

____ 4. Store and use oxyacetylene rigs in well ventilated areas.

____ 5. Line pressure for acetylene should never exceed 15 pounds per square inch.

____ 6. The acetylene cylinder valve should only be opened 1/4 to 1/2 turn.

____ 7. A cigarette lighter is excellent for lighting the oxyacetylene torch.

____ 8. The torch may be used to dust off a work bench or clothing.

____ 9. Acetylene and oxygen regulators may be switched.

____ 10. The oxygen cylinder valve should be opened slowly to prevent a sudden surge on the regulator.

____ 11. The regulator adjusting screw should be open or loosened before opening the cylinder valve.

____ 12. Hoses taken from storage should be blown out before attaching the torch.

____ 13. A leaky hose may be spliced or repaired with friction tape.

____ 14. Test for leaks with soapy water, not matches.

____ 15. Prevent heat and sparks from getting to hoses and cylinders.

____ 16. Oxyacetylene goggles should always be worn when cutting or welding.

____ 17. A cylinder should never be used as a ground in an electrical circuit.

____ 18. Empty cylinders should be marked and designated as such.

____ 19. Always replace the cylinder dap when not in use.

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ARC WELDING SAFETY TEST

A. PART IDENTIFICATION:

Identify the circled parts on the arc welder illustrated below.

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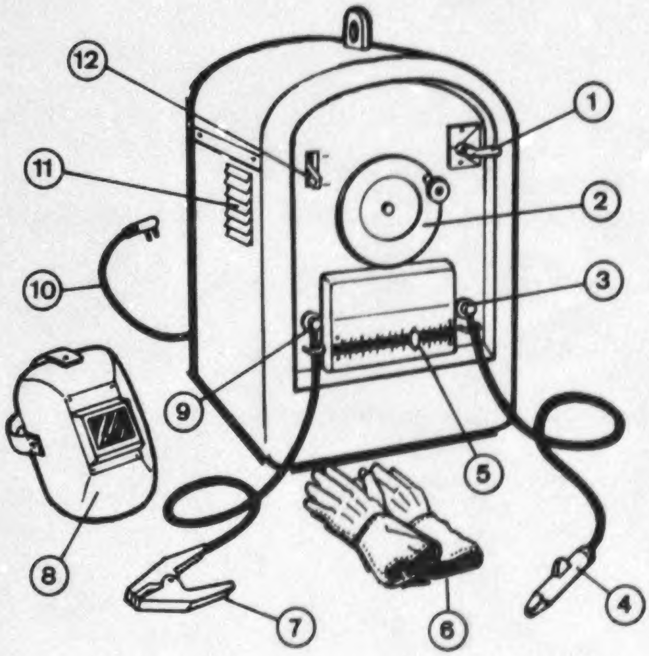

B. TRUE OR FALSE: (Place T or F in the blank)

_____ 1. Safety glasses should be worn when chipping slag.

_____ 2. Give the word "cover" to all people standing by before striking an arc.

_____ 3. The ground and electrode cables are constructed so that machinery can run over them and sharp objects will not penetrate the insulation.

_____ 4. Leather gloves and rubber-soled boots should be worn in order to safely weld while standing in water or on a wet surface.

______ 5. Hot metal may be handled with the gloves or hot metal tongs.

______ 6. Welding should be done only in well ventilated areas.

______ 7. Welding should never be done in or near an area containing combustible materials.

______ 8. Hot electrode stubs may be disposed of in the paper trash container at the end of each class.

______ 9. When the electrode is burned close to the holder, the electrode holder can be cooled in water.

______ 10. The lens specification depends upon the amperage used and the type of welding to be done.

______ 11. Examine the helmet and lens before each use to check for cracks.

______ 12. The electrode holder may be placed on the table, between the knees, or under the arm when not welding.

______ 13. Proper dress for welding includes buttoned collars and cuffless pants.

______ 14. Standing on grounded metal when welding could be dangerous.

______ 15. It is safe to observe welding from a distance without eye protection.

______ 16. Welding on closed containers could be dangerous.

______ 17. If the electrode sticks, raise helmet and determine the problem.

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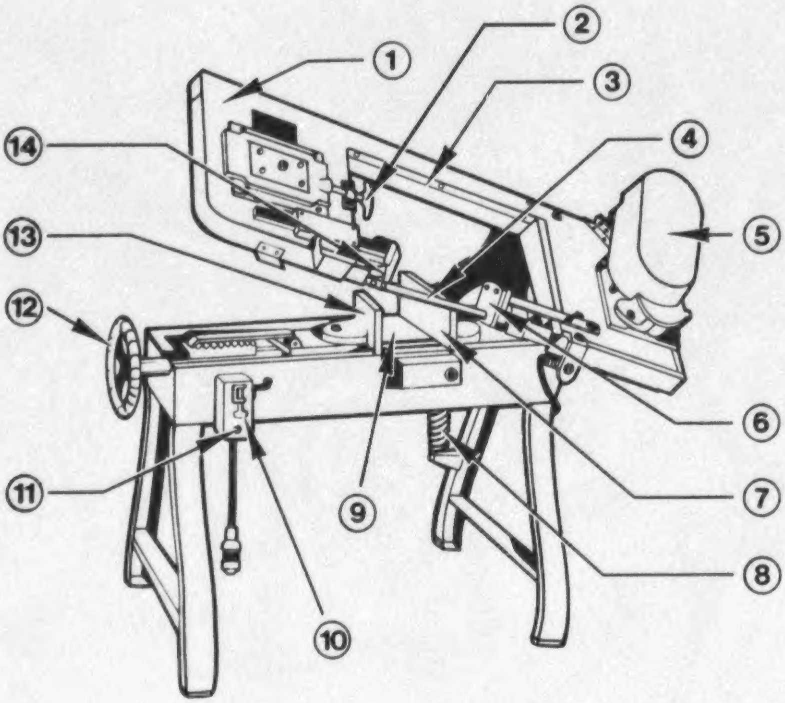
METAL CUTTING BAND SAW SAFETY TEST

A. PART IDENTIFICATION:

Identify the circled parts on the metal cutting band saw illustrated below.



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B. TRUE OR FALSE: (Place T or F in the blank)

_____ 1. Safety glasses are not necessary while operating the metal cutting band saw.

_____ 2. Loose fitting clothing with sleeves rolled above the elbows should be worn while operating the metal cutting band saw.

_____ 3. Adjustments and minor repairs can be made with the machine running.

______ 4. After the saw has stopped, chips should be removed with a brush, not bare hands.

______ 5. Metal should be properly placed and held securely in the vise before starting the saw cut.

______ 6. Long stock should be supported while sawing.

______ 7. Sawing speed should be increased by applying pressure on the head or handle.

______ 8. The saw blade should be installed with the teeth pointing toward the motor in the direction of rotation.

______ 9. Tighten the blade until it is snug, being careful not to over tighten it.

______ 10. When a blade is replaced, do not start the new blade in the old saw kerf because the new blade is thicker and will be damaged.

______ 11. The adjustable blade guide should be as close to the work as possible.

______ 12. After checking for accuracy, raise the blade and start the saw, then lower the blade gently onto the work.

______ 13. Before the cut is complete the material can be broken off.

______ 14. Hands should be kept a reasonable distance from the blade when cutting.

______ 15. The metal cutting band saw can be left running for short periods of time when unattended.

______ 16. The work area should be kept clean and free from scrap materials.

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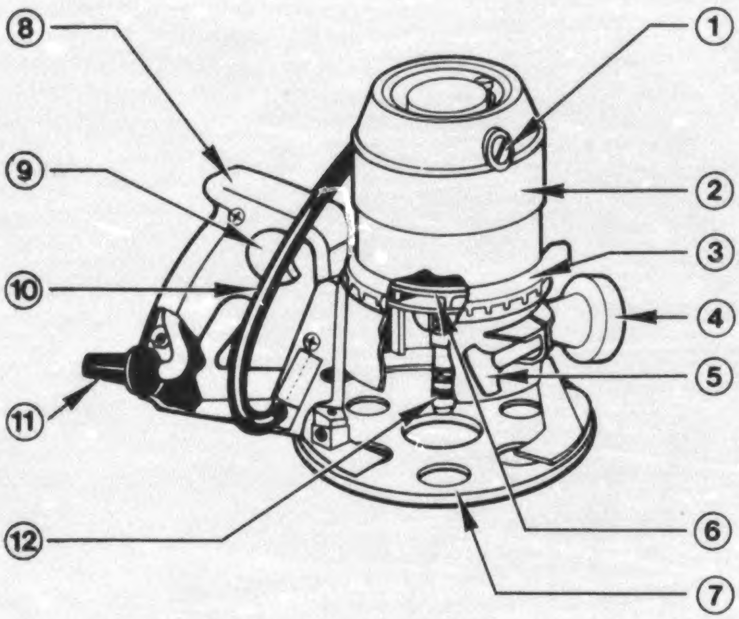
ROUTER SAFETY TEST

A. PART IDENTIFICATION:

Identify the circled parts on the router illustrated below:



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B. TRUE OR FALSE: (Place T or F in the blank)

_____ 1. Safety glasses should be worn while operating the router.

_____ 2. Disconnect the router from the power source while making adjustments.

_____ 3. The bit should be inserted into the chuck at least 1/2" and tightened securely.

_____ 4. Operate the router only in a safety grounded circuit.

_____ 5. Be sure the motor switch is on before connecting the router to the power source.

_____ 6. The router should be started when the cutter bit is in contact with the stock.

____ 7. The router is a dangerous power tool because the cutter bit travels at 20-30 thousand RPM's and the bit is not guarded.

____ 8. The work area should be free of debris and the operator should maintain a proper stance to resist the starting torque.

____ 9. The router should be held with both hands and, when making a long straight cut, moved from left to right.

____ 10. When making circular cuts, move counterclockwise around the circle.

____ 11. Use a fast feed to prevent overloading the motor.

____ 12. Allow the motor to stop before placing the router on the work bench.

____ 13. The router should be stored with the cutter bit left in the chuck.

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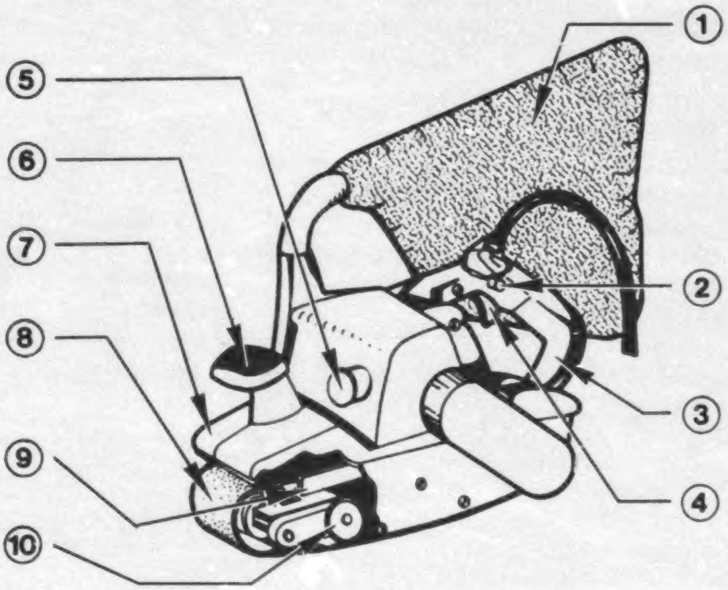
PORTABLE BELT SANDER SAFETY TEST

A. PART IDENTIFICATION:

Identify the circled parts on the belt sander illustrated below.



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B. TRUE OR FALSE: (Place T or F in the blank)

_____ 1. Operate the sander in a safety grounded circuit.

_____ 2. When replacing the belt, place it over the pulleys with the arrow on the back of the belt pointing in the direction of travel.

_____ 3. Safety glasses should be worn when operating the belt sander.

_____ 4. Long sleeve shirts and neckties are not hazardous when operating the belt sander.

_____ 5. Allow the front of the belt to come in contact with the lumber first when starting the sanding operation.

_____ 6. Move the sander lightly back and forth with the grain while sanding.

______ 7. The belt sander should be lifted off the work before stopping the motor.

______ 8. The motor should be completely stopped before placing the sander on the work bench.

______ 9. The belt sander may be carried by the power cord.

______ 10. Turn the sander on its side so the belt will not touch the work bench, pull the trigger switch, and check and adjust the belt alignment or tracking.

______ 11. Before using the sander, check the condition of the belt to see that is not frayed or filled with glue and sanding dust.

______ 12. The size of the belt sander is determined by the width and length of the sanding belt.

______ 13. It is safe to operate the sander with one hand.

______ 14. Clamp the stock to be sanded in a vise or to the work bench.

______ 15. The dust bag should be emptied and the sander cleaned before storing.

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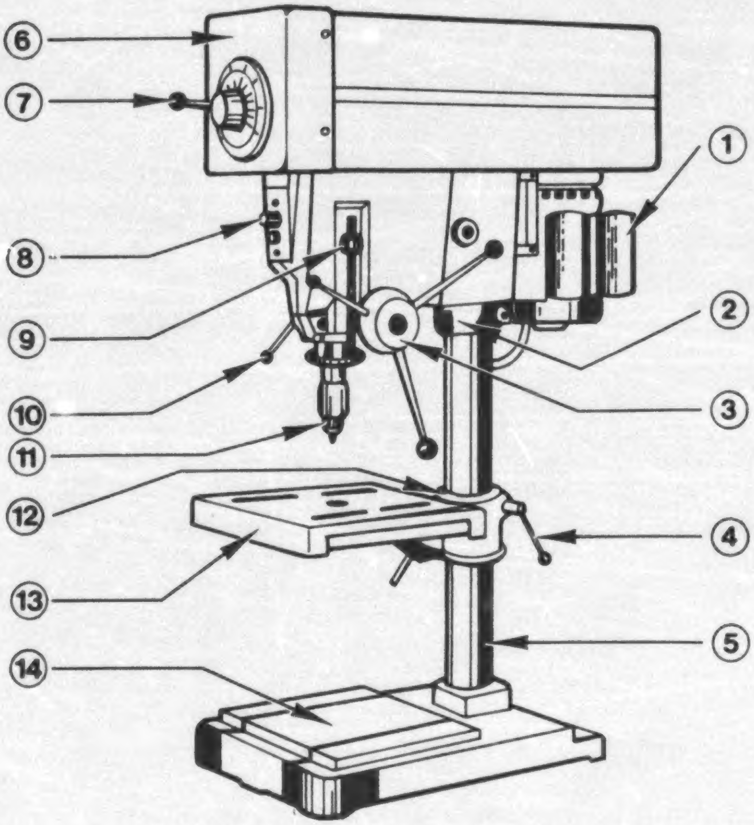
DRILL PRESS SAFETY TEST

A. PART IDENTIFICATION:

Identify the circled parts on the drill press illustrated below.



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B. TRUE OR FALSE: (Place T or F in the blank)

_____ 1. Stock should be clamped firmly and, when drilling round stock, use a "V" block vise.

_____ 2. The stock should be backed up with a block of wood to prevent damage to the table.

_____ 3. The drill should be sharp and ground at the proper angle.

______ 4. As a general rule, the larger the bit size the slower the drill speed.

______ 5. When drilling metal, use a center punch to mark the starting point of the drill.

______ 6. When drilling metal, use a pilot hole for holes larger than 1/2 inch.

______ 7. The use of cutting oil is optional when drilling steel.

______ 8. Sheet metal should be clamped between two blocks of wood, and the operator should drill through wood and metal.

______ 9. Safety glasses and loose clothing are a must when operating the drill press.

______ 10. When drilling long stock, place the long end to the left so it will hit the column, not the operator, should it slip and rotate.

______ 11. Be sure the chuck is tight on the drill and that the chuck wrench has been removed prior to drilling.

______ 12. Chips should be removed from the table with the forefinger.

______ 13. Gloves should be worn when operating the drill press to protect from burns.

______ 14. Long hair should be tied back or covered to prevent it from getting caught in the chuck.

______ 15. The drill should be forced through the stock as fast as it will go.

______ 16. The drill speed is the same for all types of work.

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SHOP SAFETY TEST

TRUE OR FALSE: (Place T of F in the blank)

_____ 1. Most accidents are caused by carelessness.

_____ 2. Training for safety is as important as training to use a hand tool or a piece of power equipment.

_____ 3. Files should be used without a handle.

_____ 4. Fragments from a cold chisel with a mushroom head can cause injury.

_____ 5. Sharp edged tools should be carried in clothes pockets and not left lying on the floor.

_____ 6. Electrical extension cords should not be used if the insulation is broken or if wire is exposed.

_____ 7. Extension cords should be three wire and of adequate gauge for amperage required.

_____ 8. Poor shop behavior leads to accidents.

_____ 9. Use of a chisel in place of a screwdriver or a wrench in place of a hammer is sometimes necessary.

_____ 10. A clean well organized shop is a safe shop in comparison to a dirty, cluttered shop.

_____ 11. Wearing proper clothes, eye protectors, and the proper use of tools are three important safety practices.

_____ 12. An adequate ventilation system is a must for tractor mechanics, welding, and paint areas.

_____ 13. The purposes of shop safety rules are to protect the individual, the tools, and the facilities.

_____ 14. The shop will be a safer place to work after the worker learns the meaning of safety colors.

______ 15. Red identifies fire extinguishers and exits.

______ 16. Orange means danger and refers to moving parts.

______ 17. Yellow designates caution as applied to controls and hazardous areas.

______ 18. Green is used to mark first aid equipment.

______ 19. Tools in poor condition are dangerous.

______ 20. Start a nail by holding it next to the point and striking the head squarely with light hammer blows.

______ 21. If at all possible, push on a wrench to tighten or loosen a nut.

______ 22. When using an adjustable wrench, pressure can be applied to either jaw.

______ 23. Extra leverage added to wrenches or the use of a hammer will help in loosening a tight nut.

______ 24. Combustible materials should be properly stored in metal cabinets.

______ 25. When using power tools, be sure all safety guards are in place and functional.

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